ASIAN POPULATION STUDIES SERIES
No. 54

MODELLING ECONOMIC AND DEMOGRAPHIC DEVELOPMENT

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
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Chapter I

INTRODUCTION

A. BACKGROUND OF THE PROJECT

Most of the Governments of the ESCAP region that responded to the third United Nations population inquiry considered that, in general, their current rates of population growth posed a serious challenge to their social and economic developmental efforts. Their perception of the impact of population growth upon development varied substantially, depending upon the stage of social and economic development. Among the Governments that considered the present rate of population growth a constraint to economic and social development, 13 countries expressed the view that the most appropriate response to the constraints from rapid population growth was an interactive adjustment of both socio-economic and demographic factors. This finding coincided with an increasing recognition of the importance of the interrelationship between population and development-related variables by development planners of ESCAP countries.

At the Second Asian Population Conference, held at Tokyo in 1972, the need to integrated population factors into overall development planning schemes was stressed. It was suggested at the Conference that improved understanding of the interrelationship between demographic and socio-economic factors would provide a basis for formulating a more desirable conceptual framework for population policy.[1] These important points were reaffirmed at the 1974 World Population Conference, held at Bucharest,[2] and the Regional Post-World Population Conference Consultation, held at Bangkok in 1975.[3] Again, at the first session of the ESCAP Committee on Population, recognizing that a better understanding of the interrelationship of population factors and development variables would require an interdisciplinary approach for which new methodologies should be devised, it was recommended that ESCAP should provide assistance to member countries in the application of improved methodology for the formulation of integrated programmes of development planning.

In compliance with these recommendations are felt needs, ESCAP organized an Expert Group Meeting on Population and Development Planning at Bangkok in July 1977. Confirming the widespread recognition of the need to integrate population factors in the process of planning for development through the ESCAP region, the Expert Group recommended that ESCAP should provide both short- and long-term technical assistance to its member countries in developing country-specific economic-demographic models for policy formulation.

At its second session, held in December 1978, the ESCAP Committee on Population recommended that, in countries where adequate and reliable data were available, prototype economic-demographic models should be developed to assist member countries in obtaining a clearer understanding of the interaction between demographic factors and social and economic development.

In accordance with these recommendations, the Population Division has included in its work programme for 1979, as well as its medium-term plan for 1980-1983, activities concerning the interrelationship between population factors and other socio-economic variables. The proposal for the present project aiming at building prototype models for three countries, Indonesia, Japan and the Republic of Korea, was submitted to the Government of Japan for its financial consideration and subsequently approved in June 1979.

It is hoped that from these country-specific studies a clearer understanding will be gained to the interrelationships between demographic and socio-economic factors in the development process, not only of each participating country but eventually of other countries in the region.

B. OBJECTIVES

The long-term objective of this project is to help to widen the knowledge base for policy-makers. and others concerned with population and development planning in the ESCAP region by the appropriate application of demographic-economic simulation modelling

1 *Population Strategy in Asia*, The Second Asian Population Conference, Tokyo, November 1972, *Asian Population Study Series*, No. 28, p. 21.

2 See *Report of the United Nations World Population Conference, 1974* (United Nations publication, No. E.75.XII.3), pp.6-8.

3 See E/CN.11/1208.

techniques with the use of local manpower and data resources under technical guidance from ESCAP.

The immediate objective was to build, for a regional comparative study of population changes and development, policy-oriented demographic-ecnomic models for three selected ESCAP member countries. The following activities were envisaged in each case:

(a) A review of leading economic models specifically designed for the country in the recent past;

(b) The analysis of the role of population factors in these models;

(c) The empirical testing of "key" demographic and economic hypotheses using country-specific data when available;

(d) The construction of a multi-sectoral model by synthesizing these hypotheses;

(e) An examination of the interdependence of demographic and economic variables by simulating alternative time paths;

(f) Consideration of the policy implications of each time path in response to external stimuli on the basis of a series of sensitivity tests;

(g) Dissemination of the mechanics and policy implications of the model through appropriate publications.

The basic objectives of this work programme were set out by the Chief of the ESCAP Population Division in his opening statement to the Second Study Directors' Meeting on the Comparative Study on Demographic-Economic Model-building for Three Selected Countries of the ESCAP Region, held at Bangkok from 21 to 25 September 1981. They are:

> "to encourage and motivate country planners to prepare more effective development plans by integrating population into development planning and policies through the application of up-to-date planning models; to provide planners with appropriate techniques to consider the short-term and long-term implications of the growth of population for fixing priorities and setting targets in various development sectors; to provide guidelines for considering the implications of various socio-economic programmes and policies for fertility, mortality and migration, so that these demographic factors may be treated as endogenous variables which can be modified by making changes in planning process. Finally the report of the study may serve as a prototype model to be developed further into a very comprehensive planning model".

C. PROJECT STRUCTURE

In order to implement the research project, ESCAP organized a study team in each of the three participating countries composed of a study director (econometrician), a research associate (demographer), a research assistant (computer programmer) and a clerical assistant. The study director, with a substantial background in econometrics, was primarily responsible for conducting research work agreed upon by ESCAP and other staff members of the team.

As a first step in the development of economic-demographic models in these countries, a one-week Study Directors' meeting was held at Bangkok in November 1979 to drawn up an outline of models for the three different countries in their respective stages of demographic transition. A number of resource persons were invited to this meeting to assist in the formulation of the preliminary model design.

After the First Study Director's Meeting, the three case studies were simultaneously undertaken by study teams in their respective countries, with technical support provided by ESCAP. Owing to limited staff resources at ESCAP, consultants were recruited for four man-months to assist the secretariat in organizing and implementing the project.

Before the preparation of this final report, the Second Study Directors' Meeting was held at Bangkok in September 1981, where draft versions of each model were presented and discussed. The following persons attended the meetings:

First meeting

Study Directors

Mr. Toshio KURODA, Director, Population Research Institute, Nihon University, Misaki-cho Chiyoda-ku, Tokyo, Japan.

Mr. Hananto SIGIT, Central Bureau of Statistics, 8 Jln. Dr. Dutomo, Jakarta, Indonesia.

Mr. Sung-Yeal KOO, Korea Development Institute, P.O. Box 113, Cheongr Yang, Seoul, Republic of Korea.

Expert

Mr. Srawooth PAITOONPONG, National Economic and Social Development Board, 962 Krungkasem Road, Bangkok, Thailand.

Second meeting

Study Directors

Mr. Hananto SIGIT, Head, Economic Analysis Division, Central Bureau of Statistics, Jakarta, Indonesia.

Mr. Naohiro OGAWA, Population Research Institute, Nihon University, Tokyo, Japan.

Mr. Sung-Yeal KOO, Senior Fellow, Korea Development Institute, Seoul, Republic of Korea.

Representatives from the International Bank for Reconstruction and Development, the International Labour Organisation and the United Nations Research Institute for Social Development also participated in the meetings

D. NATURE OF THE STUDY

The central theme of the study is the application of simulation modelling techniques for population and development planning. The use of formal models in the planning process is not new to many countries in the ESCAP region. Indeed, in some countries (for example, India), planning models have been developed to a fairly high level of sophistication. However, most formal models currently used in planning treat population variables exogenously (from official population projections) and take no account of the complex set of interrelationships that exist between economic and demographic variables. Where these interrelationships are quantitively important, which is particularly the case when planning over the longer term, account must be taken of them in any rational population or development policy.

In general terms, a "model" may be defined as a conceptual framework with which a policy-maker can assess the effects and implications of policy changes. In a world of highly complex interrelationships (especially perhaps in the sphere of economic-demographic interaction), such models are inevitably highly stylized representations of the actual pattern of interrelationships. In that sense, the question of whether or not to use models in planning does not arise, since some form of model (even of the most intuitive, informal kind) is an essential prerequisite in any rational planning exercise.

There are, however, clear advantages in using more formal, mathematical and computable models of the sort constructed in this project. In his opening statement to the Second Study Directors' Meeting, the Chief of the Population Division argued that formal models could influence economic and demographic planners at different levels. He stated:

> "At the basic level they could be used to pursuade planners to recognize the importance of demographic factors in the planning process. At a somewhat higher level they could be used to convince planners that population policy should be an important component of a strategy for accelerating development. At an advanced level these models can provide planners with a better understanding of the integrated development process. Finally, at a more advanced level these models serve to improve the planning process *per se"*.

In the planning process itself, computable models have distinct advantages over informal ones as aids to policy-makers. First, they impose the discipline upon the planners to formalize their understanding of how the "real" socio-economic/demographic systems work. Secondly, formal models help planners to distinguish clearly between objectives (or targets) and instruments of policy, a distinction that is often blurred in practical planning situations. Moreover, the planner is obliged to state explicitly the assumptions that underlie specific policy actions. Thirdly, formal methods of modelling may uncover logical inconsistencies in the framework adopted for policy analysis that might not come to light using informal methods. Fourthly, computable models are capable of coping with a large number of complex interrelationships simultaneously. Feedback effects can also be incorporated more conveniently in formal models. In contrast, less formal models are of necessity small and partial in nature. Fifthly, formal models often (though not inevitably) encourage the empirical validation of key hypotheses using econometric and other techniques. By contrast, informal models may be based on invalid prior beliefs and conjectured relationships. Moreover, the very exercise of designing and calibrating a formal model often indicates areas of data inadequacy and acts as a spur to further empirical investigation of key relationships. Sixthly, the use of formal models encourages the planner to adopt the same framework when addressing different policy issues. Thus, consistency is achieved across alternative areas of policy concern.

Models of the sort outlined in this report have distinct advantages then over other less formal approaches. But there are also serious pitfalls and disadvantages in their use. Some of these have been emphasized by Arthur and McNicoll[4] and were discussed in the paper presented by Rashid Faruqee (World Bank) at the First Study Directors' Meeting.

The relationships specified in formal models are of two types, accounting and behavioural. It is difficult to derive any policy conclusions from accounting relationships, whereas behavioural relationships are often specified on the basis of very scanty knowledge about the parameters. In this sense, modelling whose systems must not proceed in advance of an appropriate understanding of the micro-relationships involved.

Moreover, even where empirical evidence is available, it is not always in a form that is convenient for modelling purposes. Wery and Rodgers,[5] in summarizing the Bachue experience in endogenizing demographic variables, concluded that the

> "major problem in building demo-economic models lies more in the formalization of all sorts of partial theories and empirical knowledge into a coherent and global frame, rather sophisticated in some ways, but also highly imperfect; and after this formalization, in converting this conceptual structure into a tool which can be effectively utilized for understanding a social system and for evaluating attempts to modify that system through policy interventions".

In formal models, relationships need to be quantitatively specified. Education, for example, is often defined as "years of schooling", while other non-quantifiable aspects may be omitted. Entrepreneurship, attitudes to work and expectations of key variables are all non-observable and, in some cases, non-quantifiable concepts. In omitting these, models may hide more than they illuminate about the sources of growth. For these and other reasons, formal models are not intended as substitutes for sound judgement, intuition and casual empiricism. They must be used carefully in the planning process and their performance reviewed by appropriate sectors experts as a check on their "reasonableness" (or otherwise). In summary, a planning model must be viewed as a capital good in a highly labour-intensive activity.

Formal models are also invariably incrementalist in nature. They operate within the given structure of the economy. But for many of the developing countries growth potential lies in changing the structure of the economy itself. Economic-demographic models are particularly vulnerable at this point. Because the effects of changes in the rate of population growth take time, planning horizons in these models often extend to 30 or 50 years. Relationships based on current or recent evidence are unlikely to hold over such lengthy periods.

Finally, greater complexity in model design does not necessarily lead to more accurate performance in simulation or forecasting. The key to "successful modelling" is the choice of the appropriate level of abstraction required for the specific policy issue under review. In long-run or perspective planning exercises, many of the details required in short-run planning may be conveniently and safely ignored. The model design must incorporate the salient features of the economic-demographic system appropriate for the policy questions being raised. Moreover, large, complex models are difficult to understand intuitively. For this reason, the modeller involved in a practical planning situation is not infrequently presented with a dilemma. In order to meet the policy-makers' concern with detail, he may be tempted to construct a large, complex model. In choosing this approach, an intuitive understanding of the model's results is lost and, with it, the interest and confidence of the policy-maker. He may, alternatively, provide a simpler and easily understood framework, which remains unused as it fails to meet the planners' interest in detail.

E. DEMOGRAPHIC-ECONOMIC MODELLING

At present, few development planning exercises in the region use formal economic-demographic models of the sort presented in this report. However, there have been a number of economic-demographic models constructed specifically for countries in the ESCAP region.[6]

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[4] W. Brian Arthur and Geoffrey McNicoll, "Large-scale simulation models in population and development: what use to planners?" *Population and Development Review*, vol. 1, No. 2 (Dec. 1975), pp. 251-265. See also G.B. Rodgers and others, "The myth of the cavern revisited: are large-scale behavioural models useful?" *Population and Development Review*, vol. 2, Nos. 3 and 4 (Sept./Dec. 1976), pp. 395-409.

[5] Rene Wery and Gerry Rodgers, "Endogenizing demographic variables in demo-economic models: the Bachue experience", paper presented at the First Study Directors' Meeting and published in the *Pakistan Development Review*, vol.19, No.3 (autumn 1980).

[6] For example, the ILO/Bachue model has been applied to the Philippines, the FAO/UNFPA model has been applied to Pakistan and Andrew Elek has constructed a model for Papua New Guinea. In addition, the Governments of Indonesia and Malaysia have undertaken feasibility studies into economic-demographic modelling under ILO sponsorship.

To some extent, these models have been designed to deal with specific issues of economic-demographic interaction. The Bachue model, for example, was concerned with issues of employment and income distribution, while the FAO/UNFPA model concentrated on production relations within the agricultural sector. The present modelling project aims to encompass those areas of economic-demographic interaction which are of particular concern in each country.

Moreover, the three countries selected in this project are at different stages of demographic transition and development. Indonesia is at an early stage of demographic transition, whilst in Japan problems of population aging are being encountered. The Republic of Korea may be considered an intermediate case; fertility reductions in the past have been significant and other population problems are of importance (especially those associated with migration and urbanization). Comparisons of model design and simulation will provide new insights into modelling demographic-economic interaction at different stages of demographic transition. In this respect, this project extends usefully similar exercises in economic-demographic modelling in the ESCAP region.

In his feasibility study (under the auspices of ILO and the Central Bureau of Statistics, Jakarta) for the construction of an economic-demographic model for Indonesia, Andrew Elek[7] set out five desirable objectives for country-specific modelling. These were:

(a) The model should be designed and constructed in each country by nationals, with limited outside assistance;

(b) The model should be based largely on existing data without requiring extensive further surveys;

(c) The model system should be implemented on computer equipment available in each country;

(d) The model should be developed within a period of three or four years;

(e) The model should be understood and used by policy-makers in making decisions on national development.

In this project, the first four objectives have been achieved. It is not easy to say whether the fifth objective will be attained. The challenge of communicating the nature and potential usefulness of the computer simulation models remains. This report is put forward in the hope that these and other similar models will find a useful place in practical planning situations in the ESCAP region.

The report is in four parts. In parts one, two and three, the models for Indonesia, the Republic of Korea and Japan are presented. In part four, the model structures and simulation results are compared and evaluated, and a summary of the major findings is presented, together with concluding remarks.

The report has not been formally edited by the United Nations.

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[7] Andrew Elek, *"Feasibility study for the construction of an economic-demographic model for Indonesia"*, (interim report), Bangkok, ILO (May 1979).

Part One

POPULATION, EMPLOYMENT AND ECONOMIC GROWTH IN INDONESIA

by

Hananto Sigit*
Central Bureau of Statistics
Jakarta, Indonesia

* Assisted by Haryono, Agus Sutanto and other staff members of the Economic Analysis Division at the Central Bureau of Statistics.

Chapter II

INDONESIA CONTEXT OF THE PROJECT

A. BACKGROUND

This study on population and economic development in Indonesia is part of the ESCAP's comparative study on Demographic-Economic Model-Building for three countries. The other countries are Japan and the Republic of Korea. These three countries are considered to represent different stages of demographic transition. Indonesia is at the initial stage of the transition, while the Republic of Korea and Japan are, respectively, at the intermediate and final stage. The results of the three country studies are therefore expected to be able to serve as a base for understanding the interrelationship of economic and demographic variables, which is useful for further studies on other ESCAP countries.

Most countries in the ESCAP region consider their current rate of population growth poses a serious challenge to their social and economic development efforts. A number of them expressed the view that the most appropriate response to the constraint from rapid population growth was an interactive adjustment of both socio-economic and demographic factors. It was also understood that improved understanding of the interrelationship between demographic and socio-economic factors would provide a basis for formulating a more desirable conceptual framework for population policy. Further, it is recognized that better understanding of these interrelationship would require an interdisciplinary approach for which new methodologies should be devised. This view leads to the necessity to integrate population factors in the process of planning for development, and this is confirmed in an Expert Group Meeting on Population and Development Planning at Bangkok in 1977. Further more concrete recommendation was given by the ESCAP committee on population at its second session in December 1978, that in countries where adequate and reliable data were available, prototype economic-demographic models should be developed to assist member countries in obtaining a clearer understanding of the interaction between demographic factors and socio-economic development.

In response to these recommendations this project on the comparative study on Demographic-Economic Model-Building for three countries is undertaken.

B. RESEARCH ON DEMOGRAPHIC-ECONOMIC RELATIONSHIPS

The negative effect of population on economic development is well recognized in Indonesia. Population pressure has become an obstacle in Indonesia's economic development to achieve better living condition for the people. To speed up the growth of the economy, concerted efforts have been attempted to slow down and control the population growth. These are undertaken by the Government as well as private organization. The increasing concern on problems imposed by high population growth had finally lead to the establishment of the National Family Planning Coordinating Board in 1969.

Despite the awareness of the population problems with their impact on economic development, and the clarity of policies adopted by the Government, not much researchs have been done to show the cause and effect relationships of population. Therefore, the policies adopted by the Government has not yet been supported by sound findings of studies. What are the effects of reduction in population growth on economic development, and what are the effects of the various policies adopted by the Government on other fields has not been sufficiently investigated yet.

There are three undertakings to explore the effects of population on economic growth in Indonesia by employing some equations denoting relationship of the variables. The first one was a study of the economic consequences of alternative patterns of inter-island migration by Widjoyo Nitisastro (1961) for his dissertation. The second one was conducted by the Demographic Institute of the University of Indonesia to investigate the social and economic benefits of fertility reduction (1971). While the third one was a two sector study of the economic consequences of alternative fertility reduction in Indonesia by Hananto Sigit (1975).

In his dissertation Widjoyo Nitisastro studied the economic effects of inter-island migration in Indonesia. Several population projections for Java-Madura and the other Indonesia islands were estimated by assuming future trends of fertility, mortality and migration from Java-Madura to the other islands. Employing Coale-Hoover frame-work, he evaluated the economic impact of migration on both donor and receiving islands. As expected, aggregate income in the receiving islands grows faster in response to the increasing migration, while the growth of income *per capita* is slower.

A study to explore the social and economic benefits of fertility reductions was constructed by Demographic Institute, Faculty of Economics of the University of Indonesia. The economic benefits of reduction in

fertility were explored using a framework developed by TEMPO, General Electric Center for Advanced Studies in Santa Barbara, California, United States, in the attempt to explore the impacts on national income of different patterns of population growths, resulted from different trends of fertility.

The influence of population exerts on GNP occurred through the production and consumption function. As factor of production labour force positively contribute to GNP. However population growth increases consumption, reduced investment and finally hinder rapid accumulation of capital. This will have effect on slowing down the growth of GNP.

It is easily predicted from the structure of the framework that the high population growth will result in higher total consumption and lower savings. The employed labour will be larger, and with a given level of income the capital requirement will be less. With the same planned GNP growth, the output *per capita* will of course lower with higher population growth. On the other hand slower population growth, will increase *per capita* income. However, capital requirement will be larger to substitute for less number of employment resulting from lower number of labour force.

The purpose of Sigit's study is to investigate the consequences of alternative fertility reductions and urbanization on several significant economic variables in Indonesia's planned economy. For this purpose an economic-demographic relationship was constructed, employing the neoclassical growth theory, modified to account for consumption as cost and as growth factor, and incorporate the important features of the Indonesian economy. Less emphasis was put on savings; it is considered as the amount left over after consumption. Some disaggregation of the economy into rural-urban and food-non-food sectors are also considered in the study.

The study is aimed at analyzing the economic consequences of population growth, and not the reverse. Four population projections are made based on four different trends of fertility. The breakdown of urban-rural population was made by assuming constant rate of urbanization as in the period 1961-1971. The different effects of this alternative population growth were examined through the following model.

A Cobb-Douglas production function was adopted by taking capital and labour as the independent variables. Capital was considered as the accumulation of economic investment, which is divided into induced and autonomous investment. The total investment, however, consists not only of economic investment but also welfare investment, demographic investment and depreciation. Induced investment was considered as a function of total consumption, while the autonomous investment was policy variable determined by the Government to achieve the targeted income growth. Welfare investment is the amount spent on social welfare services by the Government and the private sector. Depreciation allowance is the investment necessary to replace productive fixed capital used up or becoming absolute during the process of production. Demographic investment is the amount needed to achieve birth rate to the desired level. To finance total investment domestic savings and foreign fund were needed. Foreign fund was treated as residual of total investment minus savings. While savings equal to income minus consumption.

C. ROLE OF POPULATION IN ECONOMETRIC MODELS

There are not many econometric models have been constructed for the Indonesian economy. The diversity of the economic structure, political and social instability and the incompleteness of the statistical data had been the main reasons impeding model analysis of the economy. The models built so far have been very aggregative and not adequate to explain the complicated interplay of the economic variables in the Indonesian economy. Only recently after political and social stability has been achieved and statistical data improved, more detailed and comprehensive models were built.

1. ECAFE, IAEA and ICU models

The ECAFE model was published in 1964 included 8 equations based on simple Keynesian economic structure. The model was tested for 10 countries in the region including Indonesia. This aggregative national model could be easily constructed in countries where national account statistics are available. There is no attempt to take account of the Indonesia specific economic problems in the model. In this simple model, demographic variables are not included at all.

A similar model was constructed in the same year by the Institute of Asian Economic Affairs (IAEA). This model is of exactly the same size, only slightly different equations were used. ECAFE Model No. II which was introduced also in 1964 made detailed adjustment for several problems of the Indonesian economy in the 1960 s: stagnant exports, declining operation in the manufacturing industries, inflation, and levelling-off of private consumption. This model which could be considered as an extension of the former model contained 18 equations. In principle the equations could be grouped into: Government sector, private production

sector and private consumption sector forming a recursive model. Several of the coefficients in the model are not statistically significant. Eventhough the model was built to take the relevant economic problems, it could not adequately explain the objective of the construction of the model. The decline in exports following the size of domestic prices was not explained due to the inadequacy of the export functions. While the stagnancy of the manufacturing industry could not be explained.

ICU Model No. II which is based on a much simpler ICU Model No. I was constructed to take better account of the problems of the Indonesian economy as mentioned before. This model is larger in size than the ECAFE No. II Model incorporating 30 equations. Different functional relationships were employed as compared to the ECAFE Model No. II. In addition this model also extend further several of the sectors to obtain more detailed functional relationships.

In the ECAFE Model, the Institute of Asian Economic Affairs model, and the ICU model demographic variables are not taken into account. There were probably good reasons for treating population completely outside the model. The model was intended to make short run forecasts (from 5 to 10 years) of the Indonesian economy, and to stimulate the working of the economy to be able to explain the relevant economic problems during the period understudied. Problem of population growth was not yet widely and openly recognized as obstacle to economic development. Only the uneven population geographical distribution between Java and outside Java was considered as a problem for economic development, and this surely could not be taken into account in the national economic models. With no Government policy and programme on population growth, the development of births and deaths as component for population growth were left entirely with changes in the social and economic behaviour of the people. Changes in births and deaths were slow to have a marked effect on population growth during the short run. Therefore, it would have practically no effect no economic forecasts for a period of 5 to 10 years.

It is, however, surprising that labour demand and supply was not touched at all. Unemployment and underemployment were persistent problems for a longtime. A model to suit the economic condition should also be able to forecast the rate of unemployment. This actually could be easily accommodated in the model. The following two models to be discussed took account employment as one of the central problems.

2. LPEM and Gupta models

Under the direction of the Minister for Research, the Institute for Social and Economic Research, Faculty of Economics, University of Indonesia, undertook the research project in 1976 to project the perspective of the Indonesian National Economy until the year 1985 (LPEM, 1977). Important problems relevant in the Indonesian economy recently were taken into account. These include population and labour force growth, growth of sectoral production, investment requirement and sources of financing, and the perspective of the balance of payment and employment opportunities.

The perspective were made not by employing a rigid econometric model, showing relationship of economic and population variables. Rather each of the economic areas were treated separately, and later on the results were merged to see the projected gaps in the labour market, savings, foreign trade and the balance of payment. In treating each of the problems the forecast relied more on judgemental basis rather than using regression equations. But some equations are used in cases where deep insights of the problems were lacking and assessment and forecast could not be made. In essence, this study does not used a model. This is an attempt to forecast the Indonesian economy by partly using a model.

Even though, population and labour force are treated as exogeneous variables, the influence in the economic projection is well recognized. The population by age and sex is projected up to the year 1985. The projection was originally prepared by the Central Bureau of Statistics using 1971 base population and employing constant fertility and mortality (1973). These projections which were made until 1981 were extended until 1985. The use of constant fertility and mortality was justified, since the model concerns only with working age population. Reduction in fertility will affect the working age population only after a period of fifteen years, while changes in mortality will affect markedly only children below 5 years of age.

Labour force participation rate was projected specifically for male-female and for each five-year age group. By multiplying the projected working age population and the projected labour force participation rate, the total supply of labour was obtained until the year 1985. This constitutes the supply side of the labour market. The unemployment is the excess supply of labour over demand for labour, where demand for labour is the employment creation within each of the economic sectors.

The projection of employment is undertaken by making use of estimates of production elasticities of labour. Subtracting the projection of employment from the projected labour supply give the projected number

of unemployment of the labour force. Within certain limits, the sectoral economic growth and employment elasticities could be adjusted in order to obtain the desired rate of unemployment. Economic policies are suggested to be adopted in line with this finding to achieve the desired results in employment creation.

In his book "A Model for Income Distribution, Employment and Growth", Syamaprasad Gupta attempted to explore the growth potential of the Indonesian economy, as well as the effects on employment and income distribution and other consequences of adopting alternative development strategies by employing an econometric model for Indonesia. One of the primary goals is to explore the trade off between equity and growth in the long-term context of these alternative strategies. Since empirical evidence appears to indicate that although growth is necessary it alone is not sufficient to realize dual objectives of growth and equity. The purpose is therefore to explore the tradeoff between growth and equity, growth and employment, and growth and poverty. This model is trying to take account the relevant problems faced in third Development Plan: equity and growth.

In Gupta's model population is still exogeneous. Levels and trends of fertility and mortality are assumed and employed for making population projections. And the effects are traced through production and consumption.

Labour force is conventionally projected, that is by multiplying the projection of population with projected labour force participation rate. The model assumes full employment of the labour force. The remaining labour force, which can not find employment in the modern sector are all absorbed in the agricultural and other traditional sectors.

D. OBJECTIVES OF THIS STUDY

During the seventies population factor is considered to play an important role in the economy. The efforts to reduce fertility and mortality, are believed to affect the economy in not too long distance. Models started to be built to explore the economic effect of the reduction in fertility and mortality. However, these population variables are taken to be exogeneously projected based on presumed trend. Eventhough it is recognized that the population variables are also influenced by economic factors, these features could not be accomodated in the model. The main reason is, probably, there was not much study on determination of fertility and mortality.

With the availability of population survey data since 1976, estimates of fertility and mortality, as well as study on the interrelationship of fertility and mortality with other socio-economic variables could be undertaken. This make possible the inclusion of demographic factors endogenously in the model. The main purpose of this study therefore, is to construct an Economic-Demographic Model for Indonesia showing the interrelationship of the demographic and socio-economic factors. The model takes account the important features of the Indonesian economy and include important problems of population, in order to be useful for policy and planning.

Chapter III

POPULATION AND ECONOMIC DEVELOPMENT IN INDONESIA

A. THE ECONOMY OF INDONESIA

The economy of Indonesia has been fastly growing since the embarkment of the development plan in 1969 following a two period of stabilization and rehabilitation. The effort of development started after the successful undertaking to crub the high price inflation during the sixties reaching its peak in 1967 where in a year the price index had risen by 650 per cent.

Before the implementation of the first year development plan, the Indonesia economy almost stagnate. From 1960 to 1968 the real Gross Domestic Product has grown only by 2.6 per cent at constant 1973 prices per year. And since the population was growing by 2.1 per cent, the GDP *per capita* has practically experienced a period of no growth. Since the take-offer of the Government by the "new order", and priority was given to economic matters, an immediate programme to stabilize the level of prices and rehabilitation of means of production was undertaken. The successful stabilization and rehabilitation programme was followed by systematic efforts to develop the economy as outlined in the first Five Year Development Plan (1969/70-1973/74). The first Five Year Development Plan was very successful. Despite the stress of the development policy on stabilization, the economy has been rapidly growing. During the first Five Year Development Plan the real GDP had been increasing with 8.6 per cent a year at constant 1973 prices. The rapid growth of GDP during the period was mainly credited to increasing investment supported by fund from abroad. And to a great extend also due to underutilization of factors of production during the preceding period.

As oil exporter, Indonesia enjoy the benefit of the increasing price of oil, the oil production has also been rapidly growing due to greater effort put on oil exploration on-shore and off-shore in collaboration with foreign oil companies. The increasing production and price of oil has provided the Government with a large source of fund needed for investment. However, the domestic fund for investment still has to be supplemented with foreign fund, in the form of loan, grant and direct foreign investment. The rapid growth of the Indonesia economy has continue during the second Five Year Development Plan (1974/75-1979/80), with an average increased of real GDP by 7 per cent. During the second Five Year Development Plan the growth was somewhat lower due to external factors. Recession and inflation in industrial countries causing lower demand for Indonesia products and higher price of import goods. To a great extend the lower growth rate was also caused by "Pertamina Crisis", which required the foreign exchange earnings to be used for repaying the debts and renegotiating the contracts committed by the State Oil Company Pertamina.

The Development Policy during the second Five Year Development Plan was stressed on growth, while the continuing third Five Year Development Plan was on equity. The growth of the economy continue to be high. The increase in oil price and production as well as exports of other products has increased the foreign exchange reserve reaching the ultimate high in 1980. In 1979 the real GDP grew by 4.9 per cent, over the last year, while the 1980 the growth of GDP is estimated around 9.6 per cent.

B. POPULATION FACTOR IN DEVELOPMENT PLANNING

Development planning in Indonesia is guided by the socalled "Broad Outlines of the State Policy" which is adopted by the Congress, and is reviewed and adjusted every five years. The content of the Board Outlines of the State Policy is sistematized into 3 patterns of development. These include the Basic Pattern of National Development, the General Pattern of Long Term Economic Growth and the General Pattern of Five Year Development Program. It is mentioned in this Broad Outlines of the State Policy that the large population if well managed and directed could become an effective manpower which is a precious capital for development. In the General Pattern of Long Term Economic Growth, however, the necessity to cope with the rapid population growth is emphasized. If not the results of development will become meaningless and this will endanger the continuation of the next generation.

Concern on population as clearly expressed in the Broad Outlines of the State Policy above, has guided the government in adopting policies on population in the Five Year Development Plan. It is also realized that the problems require long term solution. In each Five Year Plan population policies are drawn up on what should be done within the corresponding period, and these are to be continued in the subsequent Five Year Plans. All policies are directed and integrated within a long-term goal of solving the problem of high population

growth rate and the unequal geographical distribution of the population.

C. PROBLEMS CAUSED BY SIZE, GROWTH AND AGE STRUCTURE OF THE POPULATION

A fast growing population, as in Indonesia, requires larger efforts to provide basic needs, such as, food, housing, clothing, employment, education, and health. A still much larger effort is needed if the welfare of the people will have to be improved. The need for providing more consumption goods as demanded by larger number of population will reduce the amount of saving, which is very much needed as an important source for investment. Moreover, a larger proportion of the reduced saving still have to be invested for providing social facilities for maintaining and improving the level of welfare of the people. The remaining fund from saving which is left for economic investment become relatively smaller. And since investment for generating social facilities is generally less productive, economic growth will consequently be slower. Therefore, rapid population increase will slow down economic growth at least for two reasons: less saving because of larger consumption and larger proportion of less productive investment to sustain the level of social welfare.

There are still several other arguments in favour of slower population growth for accelerating economic development. These include, for instance, with the same level of income a smaller number of population could achieve better health, education and living conditions in general. This will increase productivity of the people, which in turn speed up economic growth. On the other hand arguments in favour for larger population increase are not relevant for Indonesia, since most of them are only relevant for developed countries or for underdeveloped countries in the past where population pressure were not in existence. While as a developing country now, Indonesia is having a large number of population with a high rate of growth resulting from rapidly decreasing mortality while fertility is only recently starting to decline.

The population of Indonesia in 1976 was estimated at about 130.4 million people. With this number of population Indonesia rank as the fifth largest country in term of population after China, India, Soviet Union and the United States. The estimated number of population in 1930 was about 60.1 million people, while the first and second population census conducted after independence in 1961 and 1971 estimated the total population at 97.0 and 119.4 million, respectively. The figures show a somewhat low growth rate of about 1.5 per cent per year before the sixties. The growth rate is accelerated during the seventies, and a somewhat declining rate occurs after 1971. The low growth rate before the sixties could not accurately reflect the real growth rate within the period due to the political instability during the period, which culminated in the war for independence in the fourties. It is believed, however, that during the normal condition, the birth rate was high. The accelerated population growth during the sixties was caused mainly by the decline in the death rate, particularly, among children of under 5 years of age. While the declining growth rate after 1971 could be attributed to the success of the efforts to reduce birth rate since the second Five Year Development Plan in 1969. The phenomena of high birth rate and declining mortality rate, particularly among the youngs, has influenced the structure of the Indonesian population. The proportion of people of young ages become very large. Data from 1961 and 1971 census, as well as from the 1976 Intercensal Population Survey show an increasing proportion of people of young ages.

The increasing proportion of young people has caused the population problems to become more difficult. The need for food relatively increases since more and better nutritious food should be provided for the young generation. Expenditures for health facilities for caring the children and the youngs are also increasing. Also in the field of education more facilities should be provided for the growing number of those entering school ages. The increasing proportion of young children also caused a larger dependency rate. Such that, the employed persons are imposed with more burden. Another effect is the increase in number of those entering the labour force. More employment should therefore be provided for this larger number of young labour force.

D. POLICIES FOR SLOWING DOWN POPULATION GROWTH

As mentioned above, it will take more than one or two Five Year Development Plans to cope with the population problems in Indonesia. The policies implemented in the Second Five Year Plan is the continuation of policy adopted in the First Plan, and the policies in the Third Plan is the continuation of policies in the Second Plan. These policies in the subsequent plans are all integrated with a long term goal of solving the long term problems of population in Indonesia.

The main objectives of the population policies are to achieve, firstly, a reduction in the rate of birth by about half of the level in the early sixties within a period of 25 years; secondly, more equal and optimum population distribution through transmigration and regional development programme, and thirdly, more balanced rural-urban population distribution through

rural development and development of small cities. The objectives of reducing the number of births in Indonesia are to increase family welfare, to reduce poverty, and to enhance the physical and mental development of the chilldren as well as the general health of the mother. The effort to slow down the birth rate is fundamentally based on voluntary participation of the family in the family planning programme, such that the decision on the number of children a family should have entirely up to the family themselves, in line with the existing norms in the society. The policy will not be undertaken by putting more burden to the economically weak segment of the population, and also will not penalize the already born children.

The efforts to reduce birth rate will primarily be achieved through family planning programme, which is directly integrated with welfare programme for the mother and the children. The target of the programme is all segments of the society and this will be expanded to cover areas outside Java, including the rural areas. The strategy of the family planning programme is not only to obtain more family planning acceptors but also sustain the old acceptors. Realizing that the success of this programme in essence will be determined by the understanding of each family on population matters, the approach adopted is not only clinical method but also non-clinical. In addition development programme, policies and activities dealing with various fields are undertaken as far as possible by avoiding any contradiction with the family planning programme. This non-clinical effort to reduce birth rate includes population education, motivations toward small family, and reduction of death rate among children.

Intensification of formal and informal education will increase the awareness and knowledge on population programme and the importance of family planning programme. This population education is integrated within the existing system of education, including education for teachers, education of high school level and education for adults. In addition to population education the need to spread information on population problems and family planning programme are well recognized. And this will be undertaken through all channels of communication and through all existing mass-media.

In the second Five Year Development Plan the Government started with motivations for families to have a small number of children. In this connexion, the allowances for children of government servants has been limited to only three children. Moreover, tax education policy were reviewed and implemented in favour of small family. In addition, the old age securities were also improved to avoid strong dependency of the parents to their children during old ages. This is expected to reduce the motives to have large family.

One of the reasons to have a large number of children is children are source of family income. Especially, in low income families where many children do not go to school, in their early ages children are working and contributing to family income. In this connexion the high death rate among children and babies is an important cause for the need to have large number of births in order to have enough living children for supporting the family. Reduction in death rate, therefore, will reduce the need for large number of births. The spread of development among regions in Indonesia will reduce death rate and this in turn will support the effort to reduce birth rate. In addition, direct measures to increase the health of mothers and children, and to reduce the death rate among children are also undertaken.

Chapter IV

ESTIMATION OF THE MODEL

A. FEATURES AND LIMITATIONS OF THE MODEL

1. Relationships of the variables

The interrelationship of the variables can be clearly seen in Figure 1 set out in blocks and arrows. One block may contain one variable or more. The direction of arrows indicate the influence or determination of one variable/block to other variables or blocks.

Fertility and mortality are determined by Gross Domestic Product education and proportion of agricultural population or proportion of urban population. On the other hand education is a function of the previous years's level of income and fertility, while the proportion of agricultural population is determined in a more complex interaction of population and economic variables.

Given the current population, the level of fertility and mortality generate future population classified by age and sex. The influence of population on the economy is included through two channels. The first one is the determination of labour force, by multiplying population by the labour force participation rates. The labour force participation rates are exogeneously determined by employing information on past trends and the ILO model.

The second channel is the influence of the size of population on the level of sectoral GDP through its influence on the consumption of several products. In addition population also influences the level of domestic saving, since private saving is considered as a function of *per capita* GDP.

In addition to population, sectoral GDP is also influenced by investment of other factor inputs, such as land and fertilizer in agricultural production. The sectoral growth of GDP together with the availability of labour force determine the sectoral distribution of employment. In this process the size of unemployment is also estimated. The sectoral employment gave information on the proportion of employment in agriculture, and in turn this determines the proportion of agricultural population.

Capital formation is a function of GDP. The projected sectoral growth of GDP requires the provision of additional capital. To finance the capital formation the available sources of fund are domestic savings, foreign investment and loans from abroad. Domestic saving, which is partly determined by population size, is not sufficient to finance capital formation. It must be supplemented by funds from abroad. The foreign funds needed depend on the availability of domestic savings. Two sources of funds from abroad sought by the Government are foreign investment and foreign loans. The capability of the economy to attract suitable foreign loans will reduce the need for foreign loans. In the model, foreign investment is projected exogenously based on past trends, and then foreign loans are a residual.

The need for consumption, capital formation and exports, can be domestically produced or imported. In the indonesian economy imports are necessary for capital formation and some consumption purposes. For financing imports,- some domestic products must be exported to obtain foreign exchange. The model estimates the balance of exports and imports by substracting consumption and capital formation from GDP.

2. Economic features and limitations

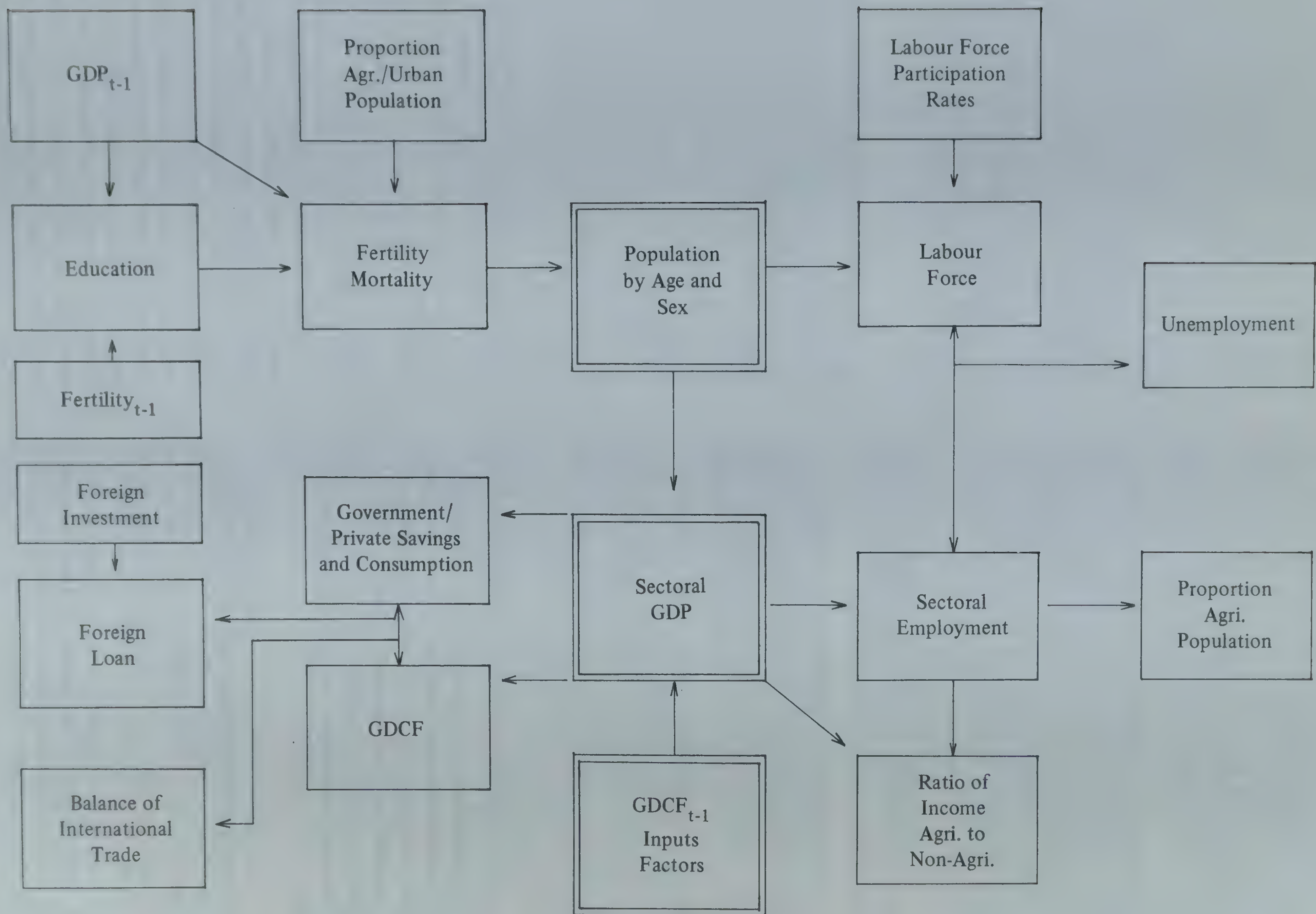
a. *Sectoral value added*

The model tries to incorporate some important problems of the Indonesian economy faced by the Government in implementing the national development plan. Not all problems of concern could be taken into account. This is probably the most important limitation of the model, since not all the important features of the economy could be depicted in the model.

The important objective of the national development plan-equity cannot be explicitly included in the model. There is no mechanism in the model to accommodate Government policy on more equal income distribution. However, some indication of the likely income distribution could be seen by comparing the sectoral distribution of value added and employment. The main reason for not being able to take account of income distribution as policy variable is lack of data. The accuracy of data on household income still being carefully examined by the Central Bureau of Statistics. Data on household expenditures cannot be used to substitute for income.

In addition to equity, another main objective of the national development plant is to be able to have a

Figure IV. 1. DIAGRAM OF THE MODEL



sustained growth of the economy. This means a continuing sufficiently rapid growth of GDP. This objective becomes the foundation of the development of the model. The projection of GDP is undertaken by examining the growth potential of different sectors of the economy, or the growth of some important commodities. In practice, the sectoral growth of the economy is actually constrained by some crucial factors. The availability of these factors will determine the growth of production of the sectors. The constraining factors might be on the supply side or demand side. Some sectors may be constrained by input factors, and these constraining input factors could be prime factors of production or investment. On the demand side, the limiting factor may be final demand or intermediate demand, that is the growth of a particular sector is a function of the growth of production of other sectors.

In this model, the sectoral breakdown and the assumptions adopted for projecting the growth of value added in each sector are the following.

In agriculture, irrigated rice is assumed to be constrained by the available irrigated land and fertilizer, while non irrigated rice is determined by the availability of non-irrigated land only. The value added of other food crops is considered to be function of household consumption expenditure. Three crops production is constrained by the availability of land used for these crops. Animal husbandry and fishery products are respectively, functions of household consumption of meat and fish. The value added of the remaining agricultural subsector, forestry, is exogenously determined.

Value added in construction depends on the amount of investment, since a large proportion of investment expenditures is in construction. Value added in construction is therefore considered to be a function of investment. The manufacturing sector is determined by the amount of investment in this sector. While value added in mining and quarrying is exogenously determined, due to lack of data for projecting them endogenously.

Agriculture, Mining & Quarrying and Manufacturing are sectors that produce goods needed for final or intermediate consumption. These sectors form the central activities of the economy. Other sectors are developing in order to facilitate the production and exchange of the products of the goods sectors. These other sectors are, therefore, considered as functions of the goods sectors. These sectors are electricity, gas & water, trade, transport & communication, bank and other financial institutions and housing rents, government and services.

b. *Investment and sources of fund*

To achieve the expected growth of value added in each sector, a specified amount of investment is needed. The estimation of required investment is done on sectoral basis, using a conventional approach. The model calculates domestic saving, which is divided into Government and private saving. The shortage of domestic saving to finance the necessary investment to achieve the projected growth of income, required the Government to seek for investment from abroad. Based on past experience the model projects exogenously the amount of foreign investment that can be attracted by the Indonesian economy. The shortage of funds for investment, after taking account foreign investment must still be supplemented by foreign loans. The model estimates this requirement of foreign loan, that the Government must seek for carrying out the national development plan.

The model is able to estimate the balance of international trade, to examine the yearly foreign trade deficit or surplus. However, it does not estimate imports and exports individually. A large proportion of capital formation must be imported. The increase in capital formation will increase import requirement. Imports are also needed for consumption purposes. Therefore, when consumption and capital formation are large, imports must be large. At the same time the capacity to export is small, since a large percentage of output is domestically consumed. In this case, the economy will likely experience a deficit in foreign trade. On the other hand, when domestic consumption and capital formation is small, imports are small and the capacity to export is large. There will be a surplus in the balance to trade. The model simply calculates the balance of trade by substracting consumption and capital formation from GDP.

c. *Employment*

Employment is of great concern to the Government. The large labour force, resulting from the large number and rapidly growing working-age population, cannot find proper employment. Due to the large proportion of traditional sectors in agriculture as well as non-agriculture, the rate of open-unemployment is very small. Only around 2 per cent of the labour force is unemployed. A large proportion of the labour force is self employed or working as irregular labour in the traditional sectors. Most of them work for less than the normal hours; they are underemployed. Due to lack of data the model cannot take into account the problem of underemployment.

The model assumes a constant open-unemployment of 2 per cent, because of the easy availability of self-employed work and work in the traditional sectors. The labour force is employed firstly in the modern non-agricultural sectors. The growth of GDP and the employment elasticities of these sectors determine the distribution of employment in the non-agricultural sectors. The traditional family system of production in the agricultural sector makes possible the absorption of the residual labour force. This is equivalent to assuming that underemployment occurs in agricultural sector. The economy as a whole still cannot provide enough employment to the large number and rapidly growing labour force. The more formal activities in the non-agricultural sectors only employ the necessary labour force, based on employment/output elasticities. Therefore, during the projection period the remaining labour force employed in the agricultural sector, exceeds the number of agricultural sector can accommodate.

Implicitly, underemployment occurs also in the non-agricultural sector. Growing employment in the informal sectors in cottage industries, trade, quarrying and services indicates the existence of underemployment (Sigit, 1979). Data by hours worked also indicate some proportion of people working below the normal working hours of 35 hours per week (CBS, 1978). People leaving rural areas, being not able to find employment in the modern sectors, have to be self-employed. Since the model used real employment elasticities, it is implicitly assumed the level of current underemployment in the non-agricultural sectors will persist in the future. While the employment condition in the agricultural sector may change depending on whether the employment demand exceed or fall short of the supply of labour.

The above implicit assumption of underemployment in the agricultural and non-agricultural sectors may be one drawback in the model. The model does not contain a mechanism to explain the flow or employment from agriculture to different non-agricultural sectors, in response, for instance, to wage differentials. Employment in non-agricultural sectors is assumed to be rapid, proportional to growth of output.

As a result of the distribution of employment, and sectoral growth of GDP, the ratio of *per capita* income between agriculture and non-agricultural sectors can be calculated. This income differential in agriculture and non-agriculture will persist, since agricultural labour cannot move to non-agriculture since the non-agricultural sectors already employed a maximum number of labour force.

3. Demographic features and limitations

On the demographic variables, the model include fertility, mortality and the percentage of the agricultural population. An important variable (related to demography) taken into account in the model is education. The model omits the important problems of population distribution between Java and outside Java. In sufficient data availability is responsible for this omission.

The total fertility rate is considered to be a function of *per capita* income, education and the percentage of people in agriculture. Given the independent variables, the model predicts the fertility level every year. The effect of increases in income and education and the change in the proportion of agricultural employment on fertility can be estimated. Mortality is determined by income/expenditure, education, urban population, the birthmonth of the children and the age of the mother at the time of giving birth. Yearly projections of mortality can also be determined in the model.

Based on the endogenously-determined fertility and mortality, the model projects population by age and sex for five year periods. For the calculation of other variables, yearly population is also estimated using simple interpolation method.

Using the exogenously-projected labour force participation rates, the model projects the increase in labour force. The growth of the labour force, then depend on the growth of population and its age-sex structure. This growing supply of labour is of great concern to the Government, as the economy cannot provide enough employment. The Indonesian economy is likely to be characterized by labour surplus for sometime to come.

Education is an important factor for fertility and mortality determination. Indicators of education incorporated in the model are the percentage of adult population (10 years and above) finishing Elementary School, the percentage of adults finishing Junior High School and the percentage of adults having no education at all. Projections of these three indicators can be made in the model.

B. ESTIMATION OF ECONOMIC EQUATIONS

1. Value added

a. *Gross Domestic Product*

To facilitate comparison with other studies on the Indonesian macro-economy, Gross Domestic Product is employed instead of Net National Product. Studies on projecting the Indonesian economy use GDP rather than GNP in order to avoid the problem of estimating Net

Factor Income from abroad. Net Factor Income from abroad in Indonesia has been relatively small. However during the past few years factor income to be paid abroad is rapidly increasing due to a rising stream of foreign investment in Indonesia. GDP measures the total value added originating within Indonesia, without due regard to ownership, whether foreign or national. For economic projections, GDP is supposed to be sufficient even though for other purposes conversion from GDP to GNP might be more desirable. This, of course could be done separately.

Data on GDP are available yearly for the period 1960-1979. Some adjustment, however, must be made since different base year pricing was used. Data for the period 1960-1973 were based on the constant 1960 price level, while for the period 1971-1979, 1973 was used as the base year for pricing. The pricing of the 1960-1970 data must be converted to 1973 base year. The 1973 base year is adopted for comparability with the current series of national income data calculated by CBS, which also use 1973 constant prices. For this purpose, a simple procedure is employed. An index for conversion is constructed, using GDP for the period 1971-1973 that are given both in 1960 and 1973 price levels. The sectoral breakdown of the GDP is also estimated using the same methodology. By the same method a series of data on government consumption private consumption gross domestic capital formation, exports and imports are calculated based on the 1973 price level. In this way, a series of data on national accounts is obtained for the period 1960-1979.

b. *Irrigated and non-irrigated rice*

During the period 1960-1979, the contribution of the agricultural sector has decreased from 51.62 to 32.24 per cent of the Gross Domestic Product. However, this sector is still the largest. The projection of value added in this sector is undertaken by examining the conditions of each sub-sector and in some cases by projecting the commodities.

More than 58 per cent of the value added in this sector is from food crops. About 66 per cent of value added of food crops in 1979 was contributed by rice. Rice is produced either on irrigated land or on non-irrigated land, where the production depends heavily on rainfall. The growth of the two types of rice production is different. Since the implementation of the first five year development plan in 1969, rice production on irrigated land has been increasing much faster than on non-irrigated land. However, even though production is growing rapidly, the Government still has to import rice to meet domestic demand, which is also growing rapidly. Therefore, for some time to come the production of rice in the country is more dependent on factors of production rather than on final demand.

The production of irrigated rice is constrained by the availability of irrigated land and fertilizer. The data on fertilizer used are available only since 1970. The data series is not long enough to justify for the estimation of production function of irrigated land rice. Gupta (1977, p. 35) has estimated the elasticities of irrigated land and fertilizer used on the value added of irrigated rice. These estimates have been checked with current data and the results are very close. Irrigated rice is therefore estimated by employing equation:

$$YIRR_t = YIRR_{t-1} \left(1 + 1.87 \frac{IRLD_t - IRLD_{t-1}}{IRLD_{t-1}} + 0.059 \frac{FTLZ_t - FTLZ_{t-1}}{FTLZ_{t-1}}\right)$$

FTLZ = ftlz x IRLD

FTLZ = Fertilizer used

ftlz = Fertilizer used per Ha

IRLD = Irrigated land.

During the period 1971-1978 fertilizer used per Ha has been fluctuating. However there is a tendency for an increase in the amount used, due to the availability of supply, ftlz is therefore projected to increase by above 3 per cent per year.

Value added of non-irrigated rice is estimated by the following:

YNIR = ynir x NILD

ynir = value added non-irrigated rice per Ha, which is exogenously growing by 3.25 per cent per year, as reflected by the development of non-irrigated rice during the year 1973-1979.

NILD = Non-irrigated land.

The growth rate of total land allocated for rice had decreased during the period 1960-1979. During the period 1960-1979, it grew by 1.10 per cent per year. However during more recent period (1969-1979) it grew only 0.99 per cent p.a. while in the period 1975-1979 only by 0.91 per cent p.a. Even though the total land area has not been growing very quickly the percentage of the irrigated land has been rapidly increasing, due to efforts to enlarge the irrigation system starting with the first development plan. On average during 1960-1979

irrigated land has been increasing by 1.50 per cent per year, and since the implementation of the five year development programme, it has been growing by 1.73 per cent per year during the period 1969-1979. In the future due to the limitation of resources, the growth of the irrigated land must be slower. It is therefore estimated to be growing by only 1.50 per cent per year. In short, the assumption on the growth of land for rice cultivation is as following:

TLLD = IRLD + NILD = Total land for rice, will grow at about 0.90 per cent per year.

IRLD = Irrigated land for rice, will be growing by 1.50 per cent per year.

NILD = Non-irrigated land equals TLLD minus IRLD.

c. *Other food crops*

This sector consists of food crops other than rice, such as corn, roots, vegetables, fruits and other food crops. An attempt to estimate the value added to the production of this sector with reference to the area planted does not produce good result. This is probably because the production of these goods is more constrained by demand, rather than by factors of production. Most of these food sectors, have income elasticities of demand less than 1. Calculation using pooled cross-section and time-series data from consumption expenditures surveys in 1969, 1970, 1978 and 1979, shows that the consumption of vegetables has an income elasticity of only 0.72. For corn and cassava, the data are only available in quantities, and the income elasticities are respectively, -0.55 and 0.24. Since vegetables are respectively cheap in Indonesia, low income people consume relatively more vegetables than high income people. Therefore, an increase in income will not increase consumption of vegetables by the same proportion. Corn and cassava are traditionally considered to be inferior goods in Indonesia. This is confirmed by their elasticities, negative for corn and very low for cassava.

Considering that the production of these other food crops is more constrained by demand, the value added to their sector is estimated by regressing onto household consumption expenditure. The result of the equation is as follows:

$$\ln YOFC = 3.4320 + 0.3503 \ln HCE$$
$$(9.1130) \quad (7.7301)$$
$$R^2 = 0.88$$

where YOFC = Value added of Other Food Crops
HCE = Household Consumption Expenditure.

d. *Tree crops*

Tree crops consist of large- and small-holder plantations. In 1979, almost 60 per cent of the value added was from the small-holder plantations. However during the period 1960-1979, the large- and the small-holder plantations experienced about the same increase in value added. The value added of these two sub-sectors are, therefore, estimated together by employing land area planted. With the data series for the period 1960-1979, a double log function of the value added of production on land area could be estimated. The result is as follows:

$$\ln YTC = -2.6019 + 1.0392\ TCLD$$
$$(-3.0585) \quad (10.2323)$$
$$R^2 = 0.93$$

where YTCP = Value added of tree crops
TCLD = Tree crops land.

Before 1968 the land area devoted to tree crops had not been growing. However, after 1969 it had grown steadily from 4,507 thousands of hectares in 1968 to about 5,650 thousands of hectares in 1977. This means an average growth of about 2.8 per cent. In the future this high growth rate is not expected to be maintained. Therefore it is expected TCLD will be growing by only around 2 per cent per year.

e. *Animal husbandry and fishery*

The production of animal husbandry and fishery is mostly constrained by domestic consumption. With the efforts by the Government to intensify cattle breeding by importing new breeds of cattle from abroad and the assistance offered in fisheries, (mainly for motorization of fishing boats) production could be stepped up to meet the demand. And since exports play a minor role, domestic demand will be the main factor constraining the level of production of meat and fish.

The production of animal husbandry and fishery are therefore considered as functions of domestic demands for meat and fish. These demand functions are estimated by employing pooled cross-section and time-series data from the National Socio-Economic Survey conducted in 1969, 1970, 1978 and 1979. For each year the households are divided into 9 classes of total expenditure, such that altogether there are 36 observations. The *per capita* demand for meat and fish are estimated with double-log functions of *per capita* consumption expenditure.

The projection of demand for meat and fish will then need the estimation of *per capita* consumption expenditure. For this purpose, a double-log regression function is estimated using *per capita* GDP as the independent variable. Time-series data for the period 1960-1979 is used for estimating the parameters. The value added of animal husbandry and fishery sub-sectors is estimated as a fraction of the total consumption of meat and fishery. Previous data suggest that the fractions are, respectively, 0.75 and 0.45 for animal husbandry and fishery.

The estimated equations are the following:

$$\ln cfsh = -3.6793 + 1.0982 \ln hce$$
$$(-11.3746) \quad (14.9041)$$
$$R^2 = 0.857$$

$$\ln cmt = -11.1388 + 1.9337 \ln hce$$
$$(-9.60765) \quad (13.8619)$$
$$R^2 = 0.838$$

$$\ln hce = -0.5346 + 0.9056 \ln y$$
$$(-74.4163) \quad (33.7049)$$
$$R^2 = 0.984$$

$$YMT = 0.75\ CMT$$
$$YFSH = 0.45\ CFSH$$
$$cmt = \frac{CMT}{P}$$
$$cfsh = \frac{CFSH}{P}$$
$$hce = \frac{HCE}{P}$$
$$y = \frac{Y}{P}$$

where CMT = Total consumption of meat
CFSH = Total consumption of fish
YMT = Value added in animal husbandry
YFSH = Value added in fishery
HCE = Household Consumption Expenditure
Y = Gross Domestic Product
P = Total Population

The t – statistics are given in brackets.

f. *Forestry*

During the period 1968-1973 value added in forestry had been growing at more than 26.7 per cent per year at 1973 constant prices. The growth is due to the Government policy which induced large-scale investment, including foreign investment, in forestry. In 1973 more than 75 per cent of wood output was for export. Due to the recession in the world economy, production of wood decreased in 1974 by 8.5 per cent and again in 1975 by 5.8 per cent. After 1975, with the recovery of the world economy and the Government policy of developing the export of processed woods (instead of logs) value added in forestry products started to increase steadily. On the average it increased by 7.8 per cent per year during the period 1975-1979.

With a continuation of current policy on further development of wood-processing, value added of forestry is expected to grow rapidly. The 7 per cent growth rate is expected to continue. This is especially true, since the level of value added in 1979 is actually only 3.8 per cent above the level in 1973, due to large decrease in the production in 1974 and 1975.

g. *Construction*

Due to a rapid increase in total investment, value added in construction rapidly increasing during the implementation of development plan following 1969. Value added of the construction sector is closely related to Gross Domestic Capital Formation, since a large proportion of the capital formation is in the form of construction. Therefore to estimate the value added of construction a regression equation is estimated using data for the period 1960-1979. The result of the estimation is the following:

$$YCTR_t = -15.0592 + 0.2600\ GDCF_{t-1}$$
$$(-1.9090) \quad (36.1441)$$
$$R^2 = 0.99$$

where YCTR = Value added in construction
GDCF = Gross Domestic Capital Formation.

h. *Manufacturing*

During the first five year development plan, 1969-1975, the manufacturing sector experienced a very rapid growth. During that period, the growth of value added per year at constant 1973 prices, on average was around 13.7 per cent. Even though, growth was slower during the second development plan period (1974-1979), the sector still experienced a high growth rate of 11.2 per cent. Since the policy of the Government is to industrialize the country, the high growth rate of this sector is assumed to continue. During the period 1980-1985, it is estimated to be growing by 11.5-13 per cent per year (LPEM, 1976, p. 80).

The high growth rate of the manufacturing sector is caused by large investment since the undertaking of systematic development in 1969. For the purpose of projecting value added of this sector, a Harrod-Domar production function is employed, since the growth of this sector is directly related to investment, whilst the labour force for many years to come will not constrain production.

Gupta (1977, p. 64) has estimated the ICOR (incremental capital-output ratio) for different manufacturing industries. For capital goods and consumption goods industries the ICOR's are estimated at 4.0. and 2.6 respectively. For estimating the investment in manufacturing industries during the past years the ICOR is estimated at 3.0. While for projections with more emphasis on modern industries the ICOR is expected to increase to 3.5.

Data on investment by sectors are not availble. The only data available is Gross Domestic Capital Formation. By using the estimated ICOR of 3.0, estimates of investment in the manufacturing sector for the past years could be generated. Based on these estimates, the future investment in manufacturing is estimated to be growing by 15.83 per cent per year.

The equation used for projecting value added in this sector is the following.

$$YMFG_t = YMFG_{t-1} + \frac{IMFG_{t-1}}{ICORC}$$

$$ICORC = 3.5$$

$$IMFG_{t-1} = IMFG_{t-2} (1 + 0.1583)$$

where YMFG = Value Added of Manufacturing sector
IMFG = Investment in Manufacturing sector
ICORC = Incremental Capital Output Ratio of Manufacturing sector.

i. *Non-goods producing sectors*

Agriculture, mining and quarrying, and manufacturing are goods-producing sectors. In essence, these sectors generate the activities of the non-goods producing sectors. The activities of the sectors, such as, services, transportation and communication, trade, electricity, banking and other financial institutions, and others are directly or indirectly generated by the production activities of the goods sectors. It was therefore decided to estimate the value added of the non-goods sectors from the level of value added of the goods sector.

The estimation is done by using national accounts statistics available annually over the period 1960-1979. The equations used and the results are as the following.

$$\ln YEGW = -12.2873 + 1.8989 \ln YAMM$$
$$(-15.3468) \quad (19.2663)$$
$$R^2 = 0.98$$

$$\ln YTRD = -4.2102 + 1.3487 \ln YAMM$$
$$(-16.2574) \quad (42.3079)$$
$$R^2 = 0.98$$

$$\ln YTRC = -6.6270 + 1.4955 \ln YAMM$$
$$(-9.1900) \quad (16.6217)$$
$$R^2 = 0.97$$

$$\ln YBFI = -16.7967 + 2.5486 \ln YAMM$$
$$(-15.5145) \quad (19.1235)$$
$$R^2 = 0.98$$

$$\ln YRGS = -3.7658 + 1.2791 \ln YAMM$$
$$(-10.1417) \quad (27.7649)$$
$$R^2 = 0.99$$

where YEGW = Value Added of Electricity, Gas and Water
YTRD = Value Added of Trade
YTRC = Value Added of Transport and Communication
YBFI = Value Added of Bank and Other Financial Institutions
YRGS = Value Added of Housing Rent, Government and Services
YAMM = Value Added of Agriculture, Manufacturing and Mining & Quarrying.

2. Investment requirement

Data on investment by economic sectors are not available. The estimation of sectoral investment will therefore contribute to the understanding of relationship between output and investment for the economic sectors under study. Estimating investment by economic sectors is also the best methodology to arrive at the estimate of Gross Domestic Capital Formation (GDCF), where GDCF is by definition the sum total of investment in all sectors of the economy.

The model computes what amount of investment is needed to achieve the projected growth of value added in each economic sector. For estimating sectoral investment, a simple Harrod-Domar relationship of investment to value added is used. Investment in a particular sector is considered equal to the increase in value added times the Incremental Capital-Output Ratio (ICOR). For uniformity the time-lag between investment and increase in value added is assumed to be one year.

In the absence of data on sectoral investment, efforts were made to estimate the value of ICOR for each sector of the economy. The World Bank and its staff members have produced figures on ICOR for most of the economic sectors (Gupta, 1979). The University of Indonesia's Social and Economic Research has also estimated the figures for some economic sectors (LPEM, 1976). These estimates are adjusted for use in this model by the sectoral growth of output and the level of Gross Domestic Capital Formation, since by definition, the sum total of the sectoral investment should equal to the given value of GDP.

The estimates of ICOR are the following:

Agriculture	= 2.3
Mining & Quarrying	= 4.0
Manufacturing	= 3.5
Electricity, Gas and Water	= 10.0
Transport and Communication	= 7.0
Construction	= 3.0
Remaining Sectors (Trade, Bank & Other Financial Institutions, Rents, Government, and Services)	= 1.5

3 Source of finance for investment

To finance the needed investment the Government has to supplement the domestic savings with loans and foreign investment. The domestic fund still falls short of the amount needed for investment to achieve the projected economic growth. However, since the proportion of domestic funds (which consist of Government and private savings) is increasing, the role of foreign fund is decreasing.

To estimate the source of finance, projections of Government Revenue and Expenditure and separately calculated. Government saving is computed as the difference between Government Revenue and Expenditure. Private saving is projected by first estimating the rate of saving to GDP. Having the estimate of domestic source of funds for investment, the source of funds from abroad is estimated by taking the difference between amount of investment needed, and the availability of domestic finance.

a. *Government revenue and expenditure*

Data on Government revenue and expenditure are available since 1960. However, there was a significant change in policy in Government spending since 1969. Before the implementation of five year development plan, there was a large and increasing deficit in the Government budget, which was financed by printing of money. This in turn caused highprice inflation. After 1969, a balanced budget policy was adopted by the Government. Government expenditure was based on how much revenue could be obtained. This policy was adopted in order to curb inflation.

The economic development of Indonesia has been successful. With a steady and high growth in GDP, Government revenue has also been rapidly growing. The increase in Government revenue has been able to produce a surplus to be used for financing investment. Government savings have also been increasing mainly due to a large increase in oil revenue. In the beginning of the first five year development plan, the ratio of Government savings to GDP was only around 4 per cent. By the end of the second five year development plan the Government savings has increased to more than 11 per cent of GDP.

To project Government savings, regression equations of Government revenue and expenditure were estimated using time-series data from 1969 to 1978. Even though the period 1969-1978 is short, the data of the period 1960-1968 must be omitted because of the significant change in policy on Government spending and efforts of revenue procurement.

The results of the regressions are the following:

$$\begin{aligned} GR &= -1101.4165 + 0.3144Y \\ &\quad (-9.4980) \quad (20.1622) \\ R^2 &= 0.99 \end{aligned}$$

$$\begin{aligned} GCE &= -260.0781 + 0.4000\, GCE_{t-1} + 0.1025Y \\ &\quad (-10.7927) \quad (1.4368) \qquad (2.6354) \\ R^2 &= 0.99 \end{aligned}$$

where GR = Government Revenue
GCE = Government Consumption Expenditure
Y = Gross Domestic Product

b. *Private savings*

There is no data at all on private saving, which consists of household and business saving. Attempts to collect data on savings through the conduct of consumption expenditure survey have not been successful for many reasons. Business savings is as difficult to estimate as household savings.

Some information on savings rate, however, is given by the Government in the development planning book. It was estimated that at the end of the first five-year development plan (1974/1975), the rate of saving was around 6.3 per cent of Gross Domestic Product. This rate was expected to increase to 9.2 per cent by 1978/1979. During the third five year development plan

the rate is predicted to be around 12 per cent. Therefore, during each development plan, the savings rate was expected to increase by about 2.9 per cent.

During the third five-year development plan the savings rate is expected to increase by 17.6 per cent, while *per capita* income is expected to increase by 22.0 per cent. Therefore for a one per cent increase in income *per capita* the savings rate will increase by about 0.80.

The savings rate could therefore be estimated by

$$\frac{PS_t}{Y_t} = \frac{PS_{t-1}}{Y_{t-1}} \left(1 + 0.80 \frac{y_t - y_{t-1}}{y_{t-1}}\right)$$

c. *Foreign fund*

Foreign funds consist of foreign investment and foreign loans. The problem of concern to the Government is how many loans from abroad are needed to supplement the domestic source of funds for investment. By definition, the foreign fund required is equal to the amount of investment minus the domestic savings. And how much loan finance is needed depends on how much is the projected foreign investment in Indonesia. In this model foreign investment is exogenously projected.

4. Employment

It is not an easy task to assess the employment situation in Indonesia. A large proportion of the population is engaged in agriculture and other informal non-agricultural sectors, such as small trading activities, cottage/home industries, quarrying, and services. The Agricultural sector only accounted for about 60 per cent of total employment in 1978. Employment in other informal sectors is also large. Approximate figures given by Sigit (1978) indicate that the largest informal employment is in trade with 90 per cent, manufacturing with 60 per cent and transportation with 35 per cent.

The agricultural sector provides much employment, since production is characterized by the family system, which will accommodate family members who cannot find employment elsewhere. Entry into informal non-agricultural sectors is also relatively easy, since there is no Government regulation preventing the people from entering these activities. Moreover, since these activities do not require a large investment, these sectors do not prevent people with limited capital and capability to be self-employed.

The above characteristics of the sectors of the economy have produced certain characteristics of employment in Indonesia which are probably similar to other developing countries. These characteristics are:

1. The level of unemployment is low and tends to be stable. The unemployed are better educated, and their parents or relatives can still support them.
2. The modern sectors are able to offer better wages and stable employment, and they are the first choice of qualified job seekers. The agricultural and other information non-agricultural sectors accommodate the remaining labour force willing to work.
3. The level of underemployment, especially in the agricultural and informal sectors is high. They are characterized by low productivity and low earning. Most of them are also forced to work for minimal hours.

The model attempts to take into account the above features of employment. Data for several years since 1960 to 1978 suggest that the open unemployment rate is around 2 per cent of the labour force. Employed labour is therefore around 98 per cent of the labour force. The employed labour force is therefore considered constant at 98 per cent for the projections.

Due to the inability to distinguish between the formal and informal sectors in the non-agriculture, the model only differentiates between agricultural and non-agricultural sectors. The non-agricultural sectors absorb labour based on a marginal productivity mechanism, so that employment elasticities of output could be estimated. The increase employment in the non-agricultural sectors, therefore, depends on the growth of output and the estimated employment elasticities. The estimated figures on employment elasticities are given in the second five year development plan (Government of Indonesia, 1974, pp. 104-105). These are agriculture 0.2, mining 0.2, manufacturing 0.5, electricity 0.2, construction 0.6, transportation 0.4, banking 0.6 and services 0.5. Based on real employment data in 1971 and 1976, Sam Suharto and Sigit (1978, p. 33) also estimated the employment elasticities which do not greatly differ from the above estimates except for the agricultural sector with an elasticity of 0.32, mining only 0.178 and construction only 0.375. Other sets of figures are given by LPEM (1976).

Based on the above the employment elasticities for several economic sectors are estimated as the following: manufacturing 0.500, mining and quarrying 0.154, construction 0.524, transport and communication 0.521, while for the remaining non-agricultural sectors is 0.432. These estimates are based on the condition of the existence of under-employment in those sectors. The

degree of underemployment assumed to persist and remain constant in the future.

The remaining labour force is accommodated in the agricultural sector. The excess supply of labour will worsen the condition of employment in this sector. The removal of excess supply of labour by economic development will gradually remove the underemployment both in agriculture and non-agricultural sectors. This process is assumed to continue until all the underemployed are removed, and then the availability of labour would become a constraint in production. However, during the period of prediction in this model, underemployment is still assumed to exist.

5. Agriculture - non agriculture income disparity

One important objective of Indonesian economic development is to achieve a more equal income distribution. Growth of real GDP is understood to be slower as a result of policies on income distribution. The Government is, therefore, content with GDP growth of 6.5 per cent per year during the third five year development plan, since development policy emphasizes programmes to help the low income segment of the population (Republik Indonesia, 1979). The emphasis on agricultural development will help a large number of low-income farmers policies to provide employment for them during off-seasons are also expected to increase their level of income. Credit policy which is directed in favour of small businessmen, and self-employed people will help them increase their productivity and their earnings.

The model does not contain sets of equations capable of explaining the income differences between various income groups. However, to give an idea of inequality in income, income disparity between agriculture and non-agriculture is computed. The possible sectoral growth of output and the mechanism for explaining sectoral employment make possible the estimation of per-worker or *per capita* income disparity between agricultural and non-agricultural sectors. This disparity in income will persist and there is no mechanism to equalize it, since it is assumed that the non-agricultural sectors have absorbed the maximum number of workers. Further entry into these sectors is not possible. The remaining labour force must be content to stay employed in the agricultural sector.

Income disparity will gradually diminish with the development of both agricultural and non-agricultural sectors. The development of the agricultural sector will increase *per capita* income in this sector. While development of the non-agricultural sectors will enhance these sectors to absorb more labour, which will ease the underemployment in the agricultural sector.

C. ESTIMATION OF DEMOGRAPHIC EQUATIONS

1. Population

Data on population of Indonesia are available for the years 1961, 1971, 1976 and 1980. The population census gave a figure of 97.018 and 119,232,000 people, respectively, for 1961 and 1971. This implied an average growth rate of 2.08 per year during the period 1961-1971. The 1980 census, however gave a surprising figure of 147,484,000 people, which means a yearly growth rate of 2.34 per cent, contrary to the assumed growth of only around 2 per cent within the decade 1971-1980. The reduction in the growth rate within this decade was thought to be due to the family planning programme and to development, which make fertility decline faster than mortality.

For some this finding from the 1980 census supported their belief that the 1961 and 1971 censuses underestimated the population figures. The high growth rate during the period 1971-1980 was mainly due to the better coverage of the more recent census. Another view was that the faster decline in mortality caused the high population growth rate during the last decade. Since there is no strong evidence of a rapid decline in mortality in Indonesia, for the construction of data on population for the years during the period 1970-1979 the growth rate is assumed to be decreasing. This means that some adjustment of the under coverage of the 1961 and 1971 censuses must be made. The degrees of underestimation estimated by the US Bureau of the Census (1979), 5.8 per cent for 1961 and 4.2 per cent for 1971, are too high, as this will over estimate the 1980 population. Cho and others (1980, p. 80) estimated that the 1971 enumerated population underestimated the total number of population by 3.6 per cent. Based on the 1980 population figure and the accepted trend growth of population, the undercoverage of the 1961 and 1971 population census is estimated at around 3 and 3.2 per cent respectively.

Based on these estimated figures for 1961, 1971 and 1980 the yearly population figures for the period 1960-1979 are calculated using exponential growth.

a. *Total fertility rate*

Based on census and survey data, several estimates of the Total Fertility Rate have been calculated by different analysts for different periods. Some of the relevant results have been put together by LK-UGM (1978) for comparison. A comprehensive estimate of fertility using 1971 population census data has been calculated by the Central Bureau of Statistics (1972). In addition, a more recent study on fertility using the

Intercensal Population Survey (1976) data has also been completed (CBS, 1979). The results of these fertility estimates are summarized in Table 2. Based on this information the Total Fertility Rate for Indonesia for every year in the period 1960-1979 is calculated using a simple interpolation method.

For estimating fertility the two indicators used are the percentage of the adult population who have never had any education (NOED), and the percentage finishing at least Junior High School (JHS). These two indicators are employed to capture the inverted shape of the curve representing the influence of education on fertility. Data from the 1976 Indonesia Fertility Survey revealed that the level of fertility increased with the level of education and only after completing Junior High School does fertility start to decline in response to the increasing level of education. The indicator NOED is used to capture the increasing segment of the fertility-education relationship, while JHS is used to represent the turning point.

Another argument used for estimating fertility is income *per capita*. To capture the effect of differences in urban and rural fertility, the Total Fertility Rate is weighted by proportion of agricultural population. This is to follow the Mason and Suits (1979) fertility function. The estimated equation is the following:

$$\ln \frac{TFR}{(0.89 + 0.11\ PAGR/P)}$$

$$= 2.6590 - 0.1178 \ln y$$
$$(151.3816) \quad (-1.0588)$$
$$-0.3137 \ln JHS - 0.1842 \ln NOED$$
$$(-3.2987) \qquad (-1.0169)$$

$$R^2 = 0.98$$

where TFR = Total Fertility Rate
PAGR = Agricultural Population
y = *per capita* GDP
JHS = Proportion finishing at least Junior High School
NOED = Proportion having no education.

b. *Child mortality*

In the absence of macro data to estimate mortality, data obtained from fertility survey conducted in 1976 is employed. The fertility survey was conducted in Java-Bali covering a sample of about 11,000 households. The functional relationship is therefore particularly valid for only Java and Bali. However, since Java and Bali cover more than 65 per cent of the population of Indonesia, with some adjustment the function could be made to represent Indonesia as a whole. The dependent variable to be estimated is child mortality.This is the proportion of children born more than five years ago who failed to survive to their fifth birthday.

Child mortality is estimated by using the following independent variables: education, expenditure per household, birthmonth, and whether the child was born to mother of ages 10-14 or 15-19 years old. This function is differentiated for urban and rural areas by employing a dummy variable. The independent variable, educational attainment, is represented by taking the proportion of respondents and their husbands finishing at least Elementary School. This is equivalent to assigning a value of 0 for the respondent or her husband who has not finished Elementary School. The scores obtained from wife and husband's education are then summed up and divided by 2. Household expenditure is employed in place of income, since income data are not available. The birthmonth of the child is calculated by multiplying the last two digits of the year of birth by 12. The resulted function is as the following.

$$CMORT = 0.5108 - 0.0165\ UR - 0.0924\ ELS - 0.0009\ HHE - 0.0004\ BMNTH + 0.0392\ A1519$$

The variable whether the children are born to mothers of age 10-14 is dropped because of small occurences. To use the above function for macro estimation some adjustments are needed. The variables from the cross-sectional household data must be transformed to macro data. The meaning of the variables in macro data are as the following:

UR = Proportion of urban population
ELS = Proportion of adults finishing at least Elementary School
HHE = Consumption Expenditure per Household
BMNTH = Current year times 12
A1519 = Proportion of children born to mothers of 15-19 years.

2. Education

There are three indicators for measuring education used in the model. Two indicators, proportion of adults never have any education (NOED) and proportion of adults finishing at least Junior High School (JHS), are used for explaining fertility. While another one, proportion of adults finishing at least Elementary School (ELS), is used as one argument in the mortality function.

Basically the level of education depends on the levels of economic development and population. The effect of economic development on education is positive, while the effect of population is negative. The higher is the level of development, the higher the level of education. While given the same level of economic development, the smaller number of population, will result in higher level of education. For this analysis *per capita* income is used to represent economic development and total fertility rate for population.

Data on education are available for the years 1961, 1971, 1976, 1977 and 1978, from various household surveys. Based on these data, estimates for the other years could be calculated to obtain yearly data for the period 1960-1979. These data are used for estimating the parameters in the regression equations for JHS and ELS. The functions are as those suggested by Mason and Suits (1979). The estimated equations are the following:

$$ELS = 316.3750 - 12.9727\ TFR. \ln y + 74.0781 \ln y - 51.4414\ TFR$$

$$JHS = 137.6172 - 6.0535\ TFR. \ln y + 35.2148 \ln y - 22.7422\ TFR$$

NOED is estimated exogenously based on past experiences and future estimate of school enrolment rates. The estimates are as follows:

Year	1961	1971	1976	1981	1986	1991	1996	2001
NOED	.6480	.4039	.2812	.1959	.1404	.1062	.0807	.0622

a. *Population projection*

The population projection by age group and sex is calculated by employing the endogenously projected levels of fertility and mortality. The base year is 1980, for which the census estimated the number of population at 148,484,000. Since the distribution by age group has not been published yet, the age distribution as estimated by the Central Bureau of Statistics (1979) is used. This age distribution is a projection of the population using the 1971–based population. To be used in the projection, the base population has been smoothed.

As usual, the projection is calculated for 5 year intervals. The level of fertility and mortality during the 5 year period is assumed to be constant. They change only at five-year intervals.

However, the yearly population must also be calculated for estimating other variables in the model. For this purpose, a simple method of exponential interpolation is used. The interpolation is also done for groups of population by age and sex.

b. *Labour force participation rate*

The base year selected for the purpose of projecting the labour force participation rate is 1976. This choice is mainly governed by the availability of detailed data on the size and structure of the Indonesian labour force. The Central Bureau of Statistics has prepared labour force projections until 1983/1984 (1979). The projection here basically adopts the methodology developed by CBS.

The labour force participation rate (lfpr) is believed to be influenced by seasonal variation. The participation rate revealed by a household survey conducted in March 1976 (busy season) is higher than the figures shown by the National Labour Force Survey (Sakernas) undertaken in the month of September-December 1976 (slack season). To eliminate the effect of seasonal variation an average of the March and the September-December figures was taken. The elimination of the seasonal effect is necessary in order to obtain the labour force figure representing the typical figure of the year to be related subsequently with income of the year. Employing lfpr in September-December will underestimate the number of labour force, while lfpr of March will overestimate it.

Participation of individuals in economic activities is influenced by a variety of social, economic and cultural factors. It is difficult, in the present state of information, to anticipate all the changes likely to result from the interaction of such complex factors governing the demand for and supply of labour in Indonesia. Thus, the methodology utilized in the present document for projecting lfpr is mainly based on informed judgements about the likely future pattern of labour force behaviour of individuals within each sex-age group in Indonesia. In forming such judgements extensive use is made of analysis of past changes based on all available data, supplemented, to the extent possible, by the experience of other countries which had passed earlier through the same stage of development as that of Indonesia.

The past trends of lfpr in Indonesia could be seen in the 1961 and 1971 population censuses and the 1976, 1977, 1978 and 1979 household surveys. The broad patterns evidenced from the data has led to the prediction of the future trends of lfpr, differentiated for males and females.

Males

Past evidence shows that lfpr for the youngest age group (10-14) years was declining. To project the future

for this group attention is paid to the Government's high priority to the achievement of universal primary education, such that by the end of the third Development Plan (1983), it is expected that all children in the age group (7-12) years will be in the primary school. It is therefore assumed that the lfpr for the age group (10-14) years will vanish, in a linear fashion, by 1991. For males belonging to the prime age groups (25-54) years, the past trend which showed slight increase, is assumed to continue in the future.

With regard to Indonesian males belonging to two selected age groups (15-19) and (55-64) years, the ILO model (1977) is considered to give a reasonably good fit. Thus these two age groups are projected based on the ratio of change for each quinquennium as revealed by the ILO models. For the age group (20-24) the lfpr is assumed to remain stable, which is, by and large, indicated by past trends. In respect of the oldest age group (65+) years, a slow rate of decline is assumed on a judgemental basis.

Females

The projection of females aged 10-14 adopts the same method as for males. The lfpr of females aged 15-64 are projected by considering past trends. The assumptions are as follows:

Ages 15-19 : increase by 0.5 per cent every 5 years

Ages 20-24 : increase by 1 per cent every 5 years

Ages 25-34 : increase by 1.5 per cent every 5 years

Ages 35-44 : increase by 1.5 per cent every 5 years

Ages 45-54 : increase by 0.5 per cent every 5 years

Ages 55-64 : decrease by 1.1 per cent every 5 years

The lfpr of females ages 65+ follows the ILO Model. The results of the estimation are as given in Table IV.1. for males and Table IV.2. for females.

c. *Percentage of agricultural population*

This variable is needed for estimating the level of fertility. In addition, this is also used for calculating *per capita* income in agriculture and non-agriculture.

For estimating the percentage of agricultural population, Harris-Todaro's functional relationship has been attempted. The movement of agriculture to non-agriculture is governed by the expected income in the two sectors. A functional relation ship as employed by Suits (1980) is used. But this model does not produce good result for Indonesia. A simple methodology is therefore used for estimating the percentage of agricultural $(\frac{PAGR}{P})$ population. This percentage depends on employment in the two sectors, which has already been determined in the model. In this case a simple relationship is adopted.

$$\frac{PAGR}{P} = k\left(\frac{EAGR}{EP}\right)$$

where EAGR = employment in agriculture

EP = total employment

From the above equation we obtain

$$\frac{EAGR}{PAGR} \quad k = \frac{EP}{P}$$

Since the percentage of agricultural population who are employed is greater than the percentage of total population who are employed, k must be less than 1. Previous data suggest that k is around 0.8.

Table IV.1. Projection of male labour force participation rate

Age group	1976	1981	1986	1991	1996	2001	2006	2011	2016	2021	2026
10–14	17.2	11.5	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15–19	60.5	57.1	53.5	49.9	46.2	42.6	39.0				
20–24	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6
25–34	97.6	97.7	97.8	97.9	98.0	98.1	98.2	98.3	98.4	98.5	98.6
35–44	98.7	98.8	98.9	99.0	99.1	99.2	99.3	99.4	99.5	99.6	99.7
44–54	96.2	96.2	96.3	96.3	96.4	96.4	96.5	96.5	96.6	96.6	96.7
55–64	87.7	86.5	85.0	83.4	81.8	80.1	78.4				
65+	65.2	63.1	61.0	58.9	56.8	54.7	52.6	50.5	48.4	46.3	44.2
All ages	74.3	73.0	72.6								

Table IV.2. Projection of female labour force participation rate

Age group	1976	1981	1986	1991	1996	2001	2006	2011	2016	2021	2026
10–14	12.4	8.3	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15–19	38.7	39.2	39.7	40.2	40.7	41.2	41.7	42.2	42.7	43.2	43.7
20–24	42.4	43.4	44.4	45.4	46.4	47.4	48.4	49.4	50.4	51.4	53.4
25–34	46.0	47.5	49.0	50.5	52.0	53.5	55.0	56.5	58.0	59.5	61.0
35–44	54.4	55.9	57.4	58.9	60.4	61.9	63.4	64.9	66.4	67.9	69.4
45–54	54.5	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5
55–64	43.4	42.3	41.2	40.1	39.0	37.9	36.8	35.7	34.6	33.5	32.4
65+	23.1	21.3	19.4	17.5	15.5	14.0	12.4				
All ages	40.2	39.5	39.9								

Chapter V

POLICY SIMULATION

A. ORDER OF COMPUTATION FOR SIMULATION

1. Specification for simulation

Three simulations are computed under different assumptions of the parameters. The first projection is based on assumptions following past trends. As far as possible, the value of the parameters obtained by employing past data are maintained during the projection. Only when it is strongly felt that the estimated parameters will change in the future, the parameters are modified. This projection is termed "high growth" since the past has experienced high and accelerated growth of GDP. If this will continue in the future, the rate of growth of GDP will accelerate.

The high growth during the past may not be sustainable in the future. Sectors, such as, forestry and mining & quarrying may have a much slower rate of growth in the future. Moreover, the manufacturing sector may not be able to absorb a very high rate of investment as in the past. Taking these considerations into account, the Indonesia economy may experience a slower growth in the future. This possibility is simulated and the result of the projection is termed as "low growth".

Another factor that may change is fertility. As a guide to the future the past decline in fertility might be too slow. Due to concerted effort by the Government to reduce fertility (beginning in 1969) its effect may be felt strongly in the future. A more rapid decline in fertility is therefore anticipated. The projection based on this low fertility is computed under "low growth" condition.

As the base for discussion the projection based on past trend (high growth) is presented. The order of computation and the specification of the parameters are given below. The other two projections are then compared with this high growth projection.

2. Order of computation and specification of the parameters

1. $IRLD_t = IRLD_{t-1}\,(1+0.015)$

2. $ftlz_t = ftlz_{t-1}\,(1+0.03)$
   level off at ftlz = 225 kg/ha

3. $FTLZ_t = ftlz_t \times IRLD_t$

4. $YIRR_t = YIRR_{t-1}\left(1+1.87\,\dfrac{IRLD_t - IRLD_{t-1}}{IRLD_{t-1}} + 0.059\,\dfrac{FTLZ_t - FTLZ_{t-1}}{FTLZ_{t-1}}\right)$

5. $TLLD_t = TLLD_{t-1}\,(1+0.009)$ for 1980-1990
   $= TLLD_{t-1}\,(1+0.005)$ for 1991+

6. $NILD_t = TLLD_t - IRLD_t$
   $= 0$ for IRLD $\geqslant$ TLLD

7. $ynir_t = ynir_{t-1}\,(1+0.0325)$

8. $YNIR_t = ynir_t \times NILD_t$

9. $YR_t = YIRR_t + YNIR_t$

10. $y_{t-1} = \dfrac{Y_{t-1}}{P_{t-1}}$

11. $\ln hce_t = -0.5346 + 0.9056 \ln y_{t-1}$

12. HCE_t	=	$hce_t \times P_t$	
13. HHE_t	=	$4.75 \times hce_t$	
14. $\ln YOFC_t$	=	$3.4320 + 0.3503 \ln HCE_t$	
15. $TCLD_t$	=	$TCLD_{t-1} (1+0.02)$	
16. $\ln YTC_t$	=	$-2.6019 + 1.0392 \ln TCLD_t$	
17. $YFST_t$	=	$YFST_{t-1} (1+0.07)$	
18. $\ln cfsh_t$	=	$-3.6793 + 1.0982 \ln hce_t$	for 1980-1985
	=	$-3.6793 + 1.0900 \ln hce_t$	for 1986-1990
	=	$-3.6793 + 1.0675 \ln hce_t$	for 1991+
	=	level off at cfsh = 10 000 rupiahs	
19. $\ln cmt_t$	=	$-11.1388 + 1.9337 \ln hce_t$	for 1980-1985
	=	$-11.1388 + 1.9200 \ln hce_t$	for 1986-1990
	=	$-11.1388 + 1.9050 \ln hce_t$	for 1991+
	=	level off at cmt = 17.000 rupiahs.	
20. $CFSH_t$	=	$P_t \times cfsh_t$	
21. CMT_t	=	$P_t \times cmt_t$	
22. $YFSH_t$	=	$0.45\ CFSH_t$	
23. YMT_t	=	$0.75\ CMT_t$	
24. $YAGR_t$	=	$YR_t + YMT_t + YFSH_t + YFST_t + YOFC_t + YTC_t$	
25. YMQ_t	=	$YMQ_{t-1} (1+0.0595)$	for 1980-1985
	=	$YMQ_{t-1} (1+0.0500)$	for 1986-1990
	=	$YMQ_{t-1} (1+0.0450)$	for 1991-1995
	=	$YMQ_{t-1} (1+0.040)$	for 1996+
26. $IMFG_{t-1}$	=	$IMFG_{t-2} (1+0.1583)$	for 1980-1985
	=	$IMFG_{t-2} (1+0.1500)$	for 1986-1990
	=	$IMFG_{t-2} (1+0.1400)$	for 1991-1995
	=	$IMFG_{t-2} (1+0.1300)$	for 1996+
27. $YMFG_t$	=	$YMFG_{t-1} + \dfrac{IMFG_{t-1}}{ICORC}$	
28. ICORC	=	3.5	for 1980-1990
	=	3.75	for 1991-1995
	=	4.00	for 1996+
29. $YAMM_t$	=	$YAGR_t + YMFG_t + YMQ_t$	
30. $\ln YEGW_t$	=	$-12.2873 + 1.8989 \ln YAMM_t$	
31. $\ln YTRC_t$	=	$-6.6270 + 1.4955 \ln YAMM_t$	

32. $\ln YRMN_t = -3.6306 + 1.3552 \ln YAMM_t$

33. $IAGR_{t-1} = 2.3\,(YAGR_t - YAGR_{t-1})$

34. $IMQ_{t-1} = 4.0\,(YMQ_t - YMQ_{t-1})$

35. $IEGW_{t-1} = 8.0\,(YEGW_t - YEGW_{t-1})$

36. $ITRC_{t-1} = 6.0\,(YTRC_t - YTRC_{t-1})$

37. $IRMN_{t-1} = 1.5\,(YRMN_t - YRMN_{t-1})$

38. $YCTR_t = YCTR_{t-1} + 0.26\,(GDCF_{t-2} - GDCF_{t-3})$

39. $ICTR_{t-1} = 3.00\,(YCTR_t - YCTR_{t-1})$ for 1980-1995
$= 3.25\,(YCTR_t - YCTR_{t-1})$ for 1996+

40. $GDCF_{t-1} = IAGR_{t-1} + IMFG_{t-1} + IMQ_{t-1} + IEGW_{t-1} + ITRC_{t-1} + IRMN_{t-1} + ICTR_{t-1}$

41. $Y_t = YAMM_t + YEGW_t + YTRC_t + YRMN_t + YCTR_t$

42. $GR_t = -1101.4165 + 0.3144\, Y_t$ for 1980-1984
$= -1101.4165 + 0.3000\, Y_t$ for 1985-1989
$= -1101.4165 + 0.2875\, Y_t$ for 1990-1999
$= -1101.4165 + 0.2750\, Y_t$ for 2000+

43. $GCE_t = -260.0781 + 0.4000\, GCE_{t-1} + 0.1025\, Y_t$

44. $GS_t = GR_t - GCE_t$

45. $\frac{PS_t}{y} = \frac{PS_{t-1}}{Y_{t-1}}\left(1+0.50\,\frac{y_t - y_{t-1}}{y_{t-1}}\right)$ for 1980-1995

$= \frac{PS_{t-1}}{Y_{t-1}}\left(1+0.40\,\frac{y_t - y_{t-1}}{y_{t-1}}\right)$ for 1996+

46. $DS_t = GS_t + PS_t$

47. $FF_t = FI_t + FLN_t$

48. $FF_t = GDCF_t - DS_t - FI_t$
$t = 0$

49. $EX_t - IM_t = Y_t - GDCF_t - GCE_t - HCE_t$

50. $ELS_{t-1} = 316.3750 - 12.9727\, TFR_{t-1} \ln y_{t-1} + 74.0781 \ln y_{t-1} - 51.4414\, TFR_{t-1}$
= level off at ELS = 1.00

51. $WELS_t = 0.72\; ELS_t$

52. $JHS_t = 137.6172 - 6.0535\, TFR_{t-1} \ln y_{t-1} + 35.2148 \ln y_{t-1} - 22.7422\, TFR_{t-1}$

53. $NOED_t = NOED_{t-1} - 1.54$

54. $\ln \frac{TFR_t}{\left(0.89 + 0.11\,\frac{PAGR_{t-1}}{P_{t-1}}\right)} = 2.6590 - 0.1178 \ln y_t - 0.3137 \ln JHS_t - 0.1842 \ln NOED_t$

55. $UR_t = UR_{t-1} + 0.27$

56. BMNTH $=$ $763 + 12(t\text{-}1976)$

57. $A1519_t$ $=$ $\frac{FR1519_t}{TFR_t}$

58. $CMORT_t$ $=$ $0.51476 - 0.01645\ UR_{t-1} - 0.092921\ WELS_{t-1} - 0.00087954\ HHE_{t-1} - 0.00039533\ BMNTH_{t-1} + 0.037077\ A1519_{t-1}$ for 1980-1989

For the rest of the years follow the following patterns

Year	1990	1995	2000	2005	2010	2015	2020	2025
CMORT	0.110	0.101	0.095	0.089	0.086	0.083	0.080	0.77
Level of Mortality	17.0	17.5	17.9	18.2	18.4	18.6	18.8	19.0

59. $P_{a,s,t+5}$ $=$ $f(P_{a,s,t}, TFR, CMORT_t)$ = using model life table.

60. $P_{a,s,t+i}$ $=$ Interpolation of $P_{a,s,t}$ and $P_{a,s,t+5}$ for i = 1 to 4

61. Compute table of labour force participation rates by age and sex.

62. $MLF_{a,t}$ $=$ $mlfpr_{a,t} \times P_{a,m,t}$

63. MLF_t $=$ $\sum_a MLF_{a,t}$

64. $FLF_{a,t}$ $=$ $flfpr_{a,t} \times P_{a,f,t}$

65. FLF_t $=$ $\Sigma_a FLF_{a,t}$

66. TLF $=$ MLF + FLF

67. EP $=$ 0.98 TLF

68. $EMFG_t$ $=$ $EMFG_{t-1}\ (1+0.425\ \frac{YMFG_t - YMFG_{t-1}}{YMFG_t})$

69. EMQ_t $=$ $EMQ_{t-1}\ (1+0.154\ \frac{YMQ_t - YMQ_{t-1}}{YMQ_{t-1}})$

70. $ECTR_t$ $=$ $ECTR_{t-1}\ (1+0.524\ \frac{YCTR_t - YCTR_{t-1}}{YCTR_{t-1}})$

71. $ETRC_t$ $=$ $ETRC_{t-1}\ (1+0.521\ \frac{YTRC_t - YTRC_{t-1}}{YTRC_{t-1}})$

72. $YOTH_t$ $=$ $YEGW_t + YRMN_t$

73. $EOTH_t$ $=$ $EOTH_{t-1}\ (1+0.375\ \frac{YOTH_t - YOTH_{t-1}}{YOTH_{t-1}})$

74. $ENAG_t$ $=$ $EMFG_t + EMQ_t + ECTR_t + EOTH_t + ETRC_t$

75. $EAGR_t$ $=$ EP–ENAG

76. $\frac{PAGR}{P}$ $=$ $0.72\ \frac{EAGR}{EP}$

77. yagr = $\frac{YAGR}{EAGR}$

78. ynag = $\frac{Y-YAGR}{ENAG}$

79. yr = $\frac{yagr}{ynag}$

3. Definition of the variables

1.	YIRR	=	Value Added, Irrigated Rice
2.	IRLD	=	Irrigated Land
3.	FTLZ	=	Fertilizer
4.	ftlz	=	Fertilizer per Ha
5.	YNIR	=	Value Added, Non-Irrigated Rice
6.	ynir	=	Value Added, Non-Irrigated Rice per Ha.
7.	TLLD	=	Total Land for Rice
8.	NILD	=	Non-Irrigated Land
9.	YOFC	=	Value Added, Other Food Crops
10.	YTCP	=	Value Added, Tree Crop Products.
11.	HCE	=	Household Consumption Expenditure
12.	hce	=	Household Consumption Expenditure *per capita*
13.	HHE	=	Expenditure per Household
14.	TCLD	=	Tree Crop Land
15.	YMT	=	Value Added, Animal Husbandry
16.	CMT	=	Consumption of Meat
17.	YFSH	=	Value Added, Fishery
18.	CFSH	=	Consumption of Fish
19.	cmt	=	Consumption of Meat *per capita*
20.	cfsh	=	Consumption of Fish *per capita*
21.	y	=	Gross Domestic Product *per capita*
22.	P	=	Total Population
23.	Y	=	Gross Domestic Product
24.	YFST	=	Value Added, Forstry
25.	YAGR	=	Value Added, Agriculture
26.	YCTR	=	Value Added, Construction
27.	GDCF	=	Gross Domestic Capital Formation
28.	YMFG	=	Value Added, Manufacturing
29.	IMFG	=	Investment in Manufacturing
30.	ICORC	=	Incremental Capital Output Ratio, Manufacturing
31.	YMQ	=	Value Added, Mining & Quarrying
32.	YAMM	=	Value Added, Agriculture + Manufacturing + Mining & Quarrying
33.	YEGW	=	Value Added, Electricity, Gas and Water

34. IAGR = Investment in Agriculture
35. YTRC = Value Added, Transport and Communication
36. ICORA = ICOR, Agriculture
37. IMQ = Investment in Mining & Quarrying
38. ICORB = ICOR, Mining & Quarrying
39. IEGW = Investment in Electricity, Gas and Water
40. ICORD = ICOR, Electricity, Gas and Water
41. ICTR = Investment in Construction
42. ICORE = ICOR, Construction
43. ITRC = Investment, Transport and Communication
44. YRMN = Value Added, Trade + Bank & Financial Institutions + Transport & Communication
45. IRMN = Investment in Trade + Bank & Financial Institutions + Transport & Communication
46. GS = Government Savings
47. PS = Private Savings
48. FI = Foreign Investment
49. FLN = Foreign Loan
50. GR = Government Revenue
51. GCE = Government Consumption Expenditure
52. DS = Domestic Savings
53. EX = Exports
54. IM = Import
55. TFR = Total Fertility Rate
56. PAGR = Population in Agriculture
57. JHS = Percentage at least finishing Junior High School
58. NOED = Percentage having no education
59. CMORT = Child Mortality, Probability of dying before age 5
60. UR = Percentage of Urban Population
61. BMNTH = Birth month of the child
62. A1519 = Probability of children born to mothers age 15-19
63. ELS = Percentage at least finishing Elementary School
64. $P_{a,s,t+5}$ = Population by age group and sex, of year t+5
65. $P_{a,s,t}$ = Population by age group and sex, of year t
66. mlfpr = Male Labour Force Participation Rate
67. flfpr = Female Labour Force Participation Rate
68. MLF = Male Labour Force
69. $P_{a,m}$ = Population of age group a and sex male
70. FLF = Female Labour Force
71. $P_{a,f}$ = Population of age group a and sex female
72. TLF = Total Labour Force
73. EP = Employed Population
74. EMFG = Employment, Manufacturing

75.	EMQ	=	Employment, Mining & Quarrying
76.	ECTR	=	Employment, Construction
77.	ETRC	=	Employment, Transport & Communication
78.	YOTH	=	Value Added, Electricity, Gas & Water + Trade + Bank & Financial Institution + Rent, Government & Services
79.	EOTH	=	Employment, Electricity, Gas & Water + Trade + Bank & Financial Institution + Rent, Government Services
80.	ENAG	=	Employment, Non-Agriculture
81.	EAGR	=	Employment, Agriculture
82.	WELS	=	Percentage of women finishing at least Elementary School

B. FINDINGS OF THE SIMULATION OF HIGH GROWTH

1. Assumptions for the simulation

As described in the model, the main relationship of the variables include income, education, the percentage of agricultural workers, fertility and mortality. These variables are interlinked in a complex system. Income together with fertility and mortality determine the level of education and the percentage of agricultural employment. While the level of fertility and mortality, which are the determinants of population growth affect the level of *per capita* income, which in turn determine the level of consumption. The level of consumption is one important factor affecting the level of income, in addition to other input factors.

The level of income in some sectors is also determined exogenously, these are income in mining & quarrying and manufacturing. For the simulation, value added in mining & quarrying is assumed to be growing by 5.95 per cent (as indicated by past trends) for the period 1980-1985. This growth rate is assumed to decline to 5.00 per cent in 1986-1990, 4.50 per cent in 1991-1995 and 4.00 per cent in 1996-2010. The growth of manufacturing sector follows the Harrod-Domar growth function, where investment is estimated to grow by 15.85 per cent for the period 1980-1985, 15 per cent in 1986-1990, 14 per cent in 1991 and 13 per cent for the rest of the projection period. The estimated value of ICOR is 3.5 for 1980-1990, 3.75 for 1991-1995 and 4.00 for 1996-2010. These assumptions of growth of value added in the two sectors are important for setting up the pace of growth of the national economy, since the growth of "services" sectors depend on the growth of the three "goods" sectors, namely, agriculture, mining & quarrying and manufacturing. Constrained by the growth in agriculture and mining & quarrying investment in manufacturing can, therefore, be considered as policy variable.

The growth of the agricultural sector is partly determined by the input factors. Land is the main constraining factor for the production of rice and tree crops. For irrigated rice production is also constrained by fertilizer used. For the simulation, total land for rice is assumed to grow by 0.9 per cent for the period 1980-1990, and 0.5 per cent for 1991-2010, while total irrigated land is assumed to grow by 1.5 per cent. Fertilizer used per ha is growing by 3 per cent as reflected in the past trend, and the maximum used of fertilizer per ha is assumed to be 225 kg, as predicted by the Department of Agriculture. Land for tree crops is assumed to grow by 2.0 per cent. For fishery and animal husbandry, the growth of value added is constrained by demand. The demand elasticity of income as computed in the regressions are assumed to decline gradually during the projection period. The value of *per capita* consumption of fish and meat is constant after reaching their saturation point. Based on the simulation, the estimated maximum of per capita consumption of fish and meat, respectively at around 10.000 rupiahs and 17.000 rupiahs at 1973 constant prices per year, are reached in the year 2000. From this year on, per capita consumption of fish and meat is assumed constant.

On the demographic part of the model, the fertility trend is entirely determined by the regression equations. No further specification of the parameters is made. On the other hand, the mortality function is assumed valid only during 1980-1989. Further declines in mortality are assumed to be slower and these are exogenously specified.

2. Growth of GDP and population

Table 3 shows that GDP grows at an accelerated rate. On average the annual growth rate of GDP for the period 1980-1985 is 9.63 per cent. This yearly growth rate increases to achieve 12.97 and 14.21 per cent respectively in the periods 2001-2005 and 2006-2010. The

Table V.1. Projection of GDP and population growth

Year	Y (Billions of Rps at 1973 prices)	P (1000)	$y = \frac{Y}{P}$ (1000 Rps)	Rate of annual increase (Percentages)		
				Y	P	Y
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1979	9 963.8	144 226	69.08	5.20	2.01	3.12
1980	10 774.1	147 490	73.05	8.13	2.26	5.75
1981	11 670.1	150 990	77.29	8.32	2.37	5.80
1982	12 704.7	154 572	82.19	8.87	2.37	6.34
1983	13 935.5	158 239	88.07	9.68	2.37	7.15
1984	15 387.8	161 994	94.99	10.42	2.37	7.86
1985	17 061.3	165 838	102.88	10.88	2.37	8.31
1990	29 241.8	187 453	156.00	11.38	2.48	8.68
1995	52 478.7	211 026	248.68	12.41	2.40	9.77
2000	93 803.3	235 505	398.31	12.32	2.22	9.88
2005	172 576.6	260 908	661.45	12.97	2.07	10.68
2010	335 350.5	288 820	1 161.11	14.21	2.05	11.91

growth rate of GDP *per capita* is lower and the acceleration is slower during the period 1980-1990, since the rate of population growth is increasing. However, during 1990-2000 the growth of population starts to decrease to make the growth of *per capita* GDP faster. The growth of GDP is influenced by the growth of population and other economic parameters. *Per capita* GDP is very much influenced by the growth of population. The slowing down of population growth has resulted in a faster growth of GDP. However, since by 2000 consumption of meat and fish has reached its saturation point the growth of GDP in this year decreases. After that it increases again due to effect of the declining population growth rate.

As shown in Table V.3., during the projection period the contribution to value added from the agricultural sector has decreased markedly from 32.79 per cent in 1979 to 14.05 per cent in 1995 and to only 4.18 per cent in the year 2010. However, in absolute term as indicated in Table V.2., value added in agriculture in the same years has increased from 3,267.2 to 7,371.6 and 14,024.9 billions of rupiahs at 1973 constant prices. An increase of more than 4 times in a period of 30 years. The importance of mining has decreased substantially from 10.51 per cent in 1979 to only 1.26 per cent in 2000. This is caused by the fact that high growth rate during the past several years cannot be sustained.

The policy of maintaining high investment growth in manufacturing during the projection has caused the contribution of manufacturing to increase from 13.00 per cent in 1979 to around 24 per cent in the year 2010. The contribution to value added by this sector seems to level off starting in 2005, because of the increase in ICOR and slower investment. This has reduced the growth rate in value added.

The increase in the output of "goods sectors" has been followed by other "services sectors". The contribution of the services sector has also been increasing, since the elasticities of the services sectors to the growth of goods sectors are positive. The proportion of value added of the sectors Electricity, Gas & Water, Trade & Communication and Remaining sectors, such as, Banking & Finance, and Trade will be increasing substantially. Due to rapid increase in gross domestic capital formation, value added in construction has also been increasing markedly.

3. Investment and domestic savings

Table V.4. shows that Government saving will increase, since Government Revenue, which is a function of GDP, will increase from 2,031.2 billions of rupiahs in 1979 to 91,120.0 billions of rupiahs in 2010, while Government Expenditure will be only 52,309.0 billions

Table V.2. Sectoral distribution of gross domestic product
(billions of Rupiahs, at 1973 constant prices)

Year	YAGR	YMQ	YMFG	YEGW	YTRC	YCTR	YRMN	Y
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1979	3 267.2	1 046.9	1 295.1	60.6	535.1	562.8	3 196.1	9 963.8
1980	3 368.5	1 109.2	1 503.0	68.5	588.9	642.2	3 493.5	10 774.1
1981	3 506.5	1 175.2	1 743.8	78.4	655.6	675.9	3 834.6	11 670.1
1982	3 653.4	1 245.1	2 022.8	90.3	732.7	719.3	4 241.0	12 704.7
1983	3 814.8	1 319.2	2 345.9	104.7	822.9	816.6	4 711.4	13 935.5
1984	3 995.8	1 397.7	2 720.1	122.2	929.3	962.3	5 260.4	15 387.8
1985	4 199.4	1 480.9	3 153.6	143.6	1 055.4	1 125.5	5 903.0	17 061.3
1990	5 436.4	1 889.9	6 514.9	336.8	2 065.6	2 149.6	10 848.5	29 241.8
1995	7 371.6	2 355.3	12 647.2	838.3	4 236.2	4 231.9	20 798.1	52 478.7
2000	10 030.3	2 865.6	23 404.0	2 101.3	8 735.0	6 596.3	40 070.9	93 803.3
2005	11 800.8	3 486.4	43 222.6	5 202.1	17 836.7	14 505.1	76 522.9	172 576.6
2010	14 024.9	4 241.7	79 737.2	13 853.5	38 576.9	30 967.8	153 948.7	335 350.5

Table V.3. Percentage sectoral distribution of GDP at 1973

Year	YAGR	YMQ	YMFG	YEGW	YTRC	YCTR	YRMN	Y
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1979	32.79	10.51	13.00	0.61	5.37	5.67	32.08	100.00
1980	31.26	10.30	13.95	0.64	5.47	5.96	32.42	100.00
1981	30.05	10.07	14.94	0.67	5.62	5.79	32.86	100.00
1982	28.76	9.80	15.92	0.71	5.77	5.66	33.38	100.00
1983	27.37	9.47	16.83	0.75	5.91	5.86	33.81	100.00
1984	25.97	9.08	17.68	0.79	6.04	6.25	34.19	100.00
1985	24.61	8.68	18.48	0.84	6.19	6.60	34.60	100.00
1990	18.59	6.46	22.28	1.15	7.06	7.35	37.10	100.00
1995	14.05	4.49	24.10	1.60	8.07	8.06	39.63	100.00
2000	10.69	3.05	24.95	2.24	9.31	7.03	42.72	100.00
2005	6.84	2.02	25.05	3.01	10.34	8.41	44.34	100.00
2010	4.18	1.26	23.78	4.13	11.50	9.23	45.91	100.00

Table V.4. Projected Government and private savings
(in billions of rupiahs, at 1973 constant prices)

Year	GR	GCE	GS	PS	DS = GS+PS	Saving Rate (Percentages)		
						GS	PS	DS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1979	2 031.2	1 208.3	822.9	1 056.2	1 879.1	8.26	10.60	18.86
1980	2 286.0	1 327.6	958.4	1 195.9	2 154.2	8.89	11.10	19.99
1981	2 567.7	1 467.2	1 100.5	1 333.0	2 433.5	9.43	11.42	20.85
1982	2 892.9	1 629.0	1 263.9	1 497.2	2 761.1	9.95	11.78	21.73
1983	3 279.9	1 819.9	1 460.0	1 700.9	3 160.9	10.48	12.20	22.68
1984	3 736.5	2 045.1	1 691.4	1 952.0	3 643.4	10.99	12.68	23.68
1985	4 017.0	2 306.8	1 710.2	2 254.1	3 964.3	10.02	13.21	23.24
1990	7 305.6	4 215.5	3 090.1	4 778.3	7 868.4	10.57	16.34	26.91
1995	13 986.2	7 851.6	6 134.6	10 887.5	17 022.1	11.69	20.75	32.44
2000	24 694.5	14 592.5	10 102.0	23 624.3	33 726.3	10.76	25.18	35.94
2005	46 357.1	26 934.9	19 422.2	53 571.6	72 993.8	11.25	31.04	42.29
2010	91 120.0	52.369.0	38 751.0	131 380.0	170 141.0	11.56	39.18	50.74

of rupiahs in the year 2010. During the projection the percentage of Government saving to GDP will increase from 8.26 to 11.56 per cent. However, the contribution of Government savings to Domestic savings will be decreasing, since the rate of private savings will be increasing faster. The ratio of private saving to GDP in the year 2000 will become 25.18 per cent and 39.18 per cent in 2010. In the year 2010 the private saving rate will be more than 3 times the Government saving ratio. In this year the rate of domestic savings will reach a high level of 50.74 per cent.

Even though domestic savings will increase markedly, the amount still falls short of the requirement for investment until the year 2000. To achieve high growth rate of GDP, a large amount of capital formation is needed. As indicated in Table V.5., the portion of GDP that must be allocated for capital investment will be increasing in order to attain the high rate of growth. About 37 per cent of GDP in 2000 must be reinvested for capital formation. While for the year 2010, the figure will increase to almost 48 per cent. To finance this requirement of capital formation, domestic source of funds must still be supplemented by foreign funds. However, during the projection period the role of foreign funds will be decreasing (Table V.6.). In 1979 more than 20 per cent of GDCF was financed by funds from abroad, while in the year 1999 this percentage will reduce to only 3.44 per cent. Beginning in 2005, no foreign funds are required. Indonesia will experience a surplus of capital. With regard to domestic sources of funds, the role of Government savings will also be decreasing. At the beginning of the projection Government savings accounted for 35.02 per cent, while in 2000 it contributed only 28.92 per cent. The role of private savings has increased substantially from 44.94 to 67.64 per cent.

Table V.5. gives the projected sectoral breakdown of investment. This distribution of investment depends on the growth of value added and the assumptions on the ICOR for each economic sector. With relatively low growth and low ICOR, the proportion of investment in Agriculture is low and decreasing during the projection period. In Mining & Quarrying, with a gradually decreasing role in the economy, the proportion of investment will also decrease. The growth of investment in manufacturing, which is considered as a policy variable, is lower than the growth of the required Gross Domestic Capital Formation. This resulted in the decreasing proportion of investment in manufacturing to GDCF. The proportion of investment in other sectors is increasing, since the value added in this sector is increasing faster than the "goods sectors".

Table V.5. Investment requirement and its distribution
(at 1973 constant prices)

Year	GDCF (billions of rupiahs)	GDCF/Y x 100	Percentage distribution of investment							
			AGR	MQ	MFG	EGW	TRC	CTR	RMN	GDCF
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1979	2 350.0	23.58	9.92	10.60	30.97	3.36	16.03	10.14	18.98	100
1980	2 517.0	23 36	12.61	10.49	33.49	3.16	15.91	4.02	20.33	100
1981	2 891.4	24.78	11.69	9.67	33.77	3.29	16.00	4.50	21.08	100
1982	3 451.7	27.17	10.75	8.59	32.76	3.32	15.67	8.46	20.44	100
1983	4 079.1	29.27	10.21	7.70	32.11	3.42	15.65	10.71	20.19	100
1984	4 699.0	30.54	9.96	7.08	32.29	3.64	16.09	10.42	20.51	100
1985	4 841.9	28.38	7.14	6.12	36.04	3.82	16.33	9.99	20.57	100
1990	9 277.9	31.73	3.91	3.67	37.50	4.84	17.24	12.45	20.40	100
1995	21 984.2	41.89	7.41	1.71	30.20	6.69	19.54	12.88	21.57	100
2000	34 927.0	37.23	2.10	1.31	35.03	9.17	22.09	7.51	22.81	100
2005	72 670.3	42.11	1.27	0.77	31.02	12.02	23.85	8.06	23.01	100
2010	160 349.9	47.82	0.73	0.42	25.90	15.56	25.03	9.91	22.45	100

Table V.6. Source of fund for capital formation

Year	GDCF (billions Rps 1973 prices)	GS/GDCF x 100	PS/GDCF x 100	DS/GDCF x 100	FF/CDCF x 100
(1)	(2)	(3)	(4)	(5)	(6)
1979	2 350.0	35.02	44.94	79.96	20.04
1980	2 517.0	38.08	47.51	85.59	14.41
1981	2 891.4	38.06	46.10	84.16	15.84
1982	3 451.7	36.62	43.38	79.99	20.01
1983	4 079.1	35.79	41.70	77.49	22.51
1984	4 699.0	35.99	41.54	77.54	22.46
1985	4 841.9	35.32	46.55	81.87	18.13
1990	9 277.9	33.31	51.50	84.81	15.19
1995	21 984.2	27.90	49.52	77.42	23.58
2000	34 927.0	28.92	67.64	96.56	3.44
2005	72 670.3	26.73	73.72	100.45	0
2010	160 349.9	24.17	81.93	106.10	0

4. Labour force and employment

The growth of the labour force depends on the growth of population, its sex-age distribution and the labour force participation rates. As can be seen in Table V.7., the growth of the total labour force is somewhat lower than the population growth, even though the labour force participation rate is not decreasing. This is caused by the decline in the percentage of working age population. Since the labour force participation rate of females is projected to increase substantially, the female labour force will increase faster. In control the growth of the male labour force is slower than the population growth. In absolute term, the total labour force during 1980-1985 will be growing by more than 7 millions people. And because of population growth, the total number of additional labour is increasing, such that during 2005-2010, the labour force will increase by more than 14 million people.

As mentioned earlier, the model assumes a constant open unemployment rate of 2 per cent as indicated during the past trend. Table V.8. shows the number of unemployment increase from 1.2 million people in 1980 to almost 2.5 million in the year 2010. The employed persons will increase from 58.9 million in 1980, to 119.7 million in the year 2010. It must be stressed here once again that the employment is counted as the number of people employed, without considering the number of hours they have worked. People who work at minimum hours are considered employed, together with those working full time.

As expected the percentage of employment in agriculture will be decreasing. This is a logical consequence of the decreasing role of the agricultural sector in GDP. The percentage of employment in mining & quarrying will also be decreasing. Employment in other sectors is increasing, in line with the increase in the value added contribution. Employment in the manufacturing sector in percentage terms will increase more than twice, from 7.59 per cent in 1980 to 17.42 per cent in the year 2000. Employment in other sectors will also increase rapidly.

The growth of value added in the non-agricultural sectors during 1980-1990 is not fast enough to be able to absorb the additional labour force, such that portion of them still have to find employment in the agricultural sector. Table V.9. shows that during this period employment in agriculture will increase from 37.7 million to 40.1 million people. With the increasing growth of value added during the following periods, the non-agricultural sectors are able to absorb more employment, so that employment in the agricultural sector starts to decrease. It reduces to only 26.9 million people in the year 2000.

The reduction in the agricultural employment, will cause an increase in the average value added per employed person. Therefore both the absolute and the relative difference increase. This is an interesting finding, even though the model does not provide a mechanism for the movement of the labour force from agriculture to non-agriculture. Assumptions on the exogenous variables in the simulation produce result showing income distribution between agriculture and non-agriculture is worsening. However, compared to the increase in the value added *per capita* in the non-agricultural sector, the increase in the agricultural sector is still lower. This causes a decline in the ratio of *per capita* income of the agricultural to non-agricultural sector. This figure declines from 0.26 in 1980 to 0.15 in 2010, as shown in Table V.9.

5. Education, fertility and mortality

Education is represented by three indicators. The percentage of people having no education, percentage finishing at least Junior High School, and percentage of wife finishing at least Elementary School. The percentage having no education is exogenously projected, while the other two indicators are function of income and fertility.

The percentage of adults having no education is projected to remain only 0.98 per cent in the year 2010. In the year 2000, most of the adults will finish at least Junior High School. It can also be seen in Table V.10. that 72 per cent of wives will have finished elementary school.

Progress in education and growth of income will cause fertility and mortality to decline. During the projection period, mortality will decline faster than fertility. As compared to the level in 1980, mortality will decline by almost 50 per cent by the year 2010, while fertility during the period 1979-2010 will decline only by 25 per cent. This decline in mortality, however, is exogenously estimated. The decline in fertility might be underestimated, since there is an intensive program of fertility reduction which started in 1969. The coefficients in the fertility function are influenced by the level of fertility before the programme in 1960-1970, where the decline is very slow.

C. COMPARISON OF HIGH AND LOW GROWTH OF GDP AND FERTILITY

1. Assumptions of the projections

The model is built with a purpose to investigate the effect of population change on economic growth and the reverse. This is achieved by endogenizing fertility and mortality, where their levels are determined by *per*

Table V.7. Labour force projection
(in thousands)

Year	FLF	MLF	TLF	Rate of annual increase (Percentages) FLF	MLF	TLF
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1980	21 425.6	38 722.4	60 148.0			
1981	21 938.9	39 537.8	61 476.7	2.40	2.10	2.21
1982	22 468.0	40 410.1	62 878.1	2.41	2.21	2.28
1983	23 013.6	41 309.7	64 323.3	2.43	2.23	2.30
1984	23 579.1	42 228.3	65 807.4	2.46	2.22	2.31
1985	24 159.5	43 185.3	67 344.8	2 46	2.27	2.34
1990	27 174.5	48 046.9	75 221.4	2.38	2.16	2.24
1995	30 705.7	53 451.0	84 156.5	2.47	2.15	2.27
2000	35 308.1	59 819.7	95 127.6	2.83	2.28	2.48
2005	40 610.7	67 374.6	107 985.1	2.84	2.41	2.57
2010	46 397.9	75 705.7	122 103.6	2.70	2.36	2.59

Table V.8. Distribution of employment

Year	TLF	EP	Percentage distribution of employment EAGR	EMQ	EMFG	ECTR	ETRC	EOTH	EP	UP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1980	60 148.0	58 911.0	63.99	0.21	7.59	1.61	2.54	24.06	100	1 237.0
1981	61 476.7	60 247.1	63.39	0.21	7.86	1.62	2.61	24.31	100	1 229.6
1982	62 878.1	61 620.6	62.70	0.20	8.13	1.64	2.70	24.63	100	1 257.5
1983	64 323.3	63 036.8	61.90	0.20	8.41	1.71	2.78	24.99	100	1 285.5
1984	65 807.4	64 491.3	60.99	0.20	8.70	1.83	2.88	25.39	100	1 316.1
1985	67 344.8	65 997.8	60.03	0.19	9.00	1.95	2.99	25.83	100	1 347.0
1990	75 221.4	73 716.9	54.40	0.18	10.65	2.48	3.68	28.60	100	1 504.5
1995	84 156.5	82 473.3	47.63	0.17	12.32	3.22	4.61	32.06	100	1 683.2
2000	95 127.6	93 225.1	41.00	0.15	13.86	3.62	5.72	35.65	100	1 902.5
2005	107 985.1	105 825.4	32.99	0.14	15.51	4.90	7.04	39.42	100	2 159.7
2010	122 103.6	119 661.4	22.44	0.13	17.42	6.54	8.92	44.54	100	2 442.2

Table V.9. Agriculture and non-agricultural employment

Year	YAGR	YNAG	EAGR	ENAG	$yagr = \frac{YAGR}{EAGR}$ (1000 Rps.)	$yang = \frac{YNAG}{ENAG}$ (1000 Rps)	$\frac{yagr}{ynag}$	$\frac{EAGR}{EP}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1980	3 368.5	7 405.6	37 699.9	21 211.1	89.350.4	349 138.0	0.26	0.64
1981	3 506.5	8 163.6	38 190.3	22 056.8	91 816.8	370 117.9	0.25	0.63
1982	3 653.4	9 051.3	38 635.6	22 948.9	94 561.1	393 790.8	0.24	0.63
1983	3 814.8	10 120.7	39 018.2	24 018.6	97 769.7	421 367.8	0.23	0.62
1984	3 995.8	11 392.0	39 334.0	25 157.3	101 586.7	452 830.9	0.22	0.61
1985	4 199.4	12 861.9	39 616.4	26 381.4	106 001.4	487 535.5	0.22	0.60
1990	5 436.4	23 805.4	40 104.9	33 612.1	135 555.2	708 238.9	0.19	0.54
1995	7 371.7	45 107.0	39 285.3	43 188.0	187 644.1	1 044 434.3	0.18	0.48
2000	10 030.3	83 773.0	38 220.9	55 004.2	262 428.7	1 523 029.0	0.17	0.41
2005	11 800.8	160 775.8	34 912.9	70 912.4	338 007.1	2 267 242.0	0.15	0.33
2010	14 024.9	321 325.6	26 857.8	92 803.7	522 193.1	3 462 422.0	0.15	0.22

Table V.10. Projected level of education, total fertility rate, and child mortality

Year	NOED	JHS	WELS	TFR	Index of TFR	CMORT	Index of CMORT
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1979	23.08	11.17	0.267	4.85	100.00	0.161	100.00
1980	21.54	11.67	0.276	4.81	99.18	0.160	99.38
1981	20.00	12.27	0.287	4.76	98.14	–	–
1982	18.46	12.95	0.299	4.72	97.32	–	–
1983	16.92	13.70	0.312	4.67	96.29	–	–
1984	15.38	14.55	0.327	4.62	95.26	–	–
1985	13.84	15.50	0.343	4.57	94.23	0.125	77.64
1990	8.07	20.23	0.421	4.40	90.72	0.110	68.32
1995	4.77	26.93	0.532	4.17	85.98	0.101	62.73
2000	2.81	36.58	0.670	3.93	81.03	0.095	59.01
2005	1.66	43.90	0.720	3.82	78.76	0.089	55.28
2010	0.98	53.74	0.720	3.67	75.67	0.086	53.42

capita income and education. On the other hand the change in population growth, as determined by levels and trends of fertility and mortality, will affect some income and some other economic variables.

To observe quantitatively the interrelationship of population and economic change, three projections are prepared. The three projections are computed by employing different assumptions on economic growth and trends of fertility. Mortality is not altered since there is no definite policy, expressed in targeted figures, to reduce the level of mortality. The Mortality level is more a byproduct of health policy and economic conditions.

The three projections are termed as High Growth High Fertility (HGHF), Low Growth High Fertility (LGHF) and Low Growth Low Fertility (LGLF). Specifically the assumptions for the simulation of the three projections are as the following

1. **HGHF**

As mentioned before Investment in manufacturing (IMFG) is exogenously determined and considered as a policy variable. This projection assumes high rate growth of IMFG of 15.83 per cent at the beginning of the projection period, and this is to be slightly declining to level at 13.00 per cent in the year 1996. In addition the Forestry sector (YFST) is assumed to be growing rapidly as the past trend (7.0 per cent) and Mining & Quarrying sector (YMQ) at the beginning of the projection will be growing by 5.95 per cent, which is to decline slowly to 4.0 per cent in 1996. On the demographic side, the fertility trend is to follow the regression equation, which is slowly declining as indicated by past data.

2. **LGHF**

This simulation assumes lower IMFG, YFST and YMQ. IMFG starts with the same rate of growth of 15.83, however, it declines faster to achieve growth rates of 10 per cent in 1996 and 8 per cent in 2006. The growth of YFST is only 4 per cent and the growth of YMQ is also fastly declining to achieve only 3 per cent in 1996. In this projection the assumption on fertility is the same as that in HGHF.

3. **LGLF**

This projection assumes the same low growth of IMFG, YFST and YMQ as in LGHF. On the other hand, a faster decline of fertility is employed. The fertility trend is the follow the former target of the Government, that is to reduce level of fertility by 50 per cent during the period 1970-2000. In this case the estimated TFR in 1970 was 5.42.

2. Growth of GDP

The exogenously determined high growth of Forestry and Mining & Quarrying sectors as in the past, as well as high rate of investment in manufacturing will result in very rapid growth of GDP. As can be seen in Table 13,the rate of growth of GDP in espected to accelerate from around 8 per cent in 1980 to more than 14 per cent in the year 2010. This trend is more unlikely to happen in the future since most of the parameters obtained using past data are assumed to hold. The high growth rate of some secotrs in the past, such as, Forestry, Mining and Manufacturing, may slow down in the coming year for several reasons.

More realistic figures are shown in LGHF and LGLF projections. The growth of GDP will still accelerate during the period 1979-2000, however, it will be slower. It only accelerate from around 8 per cent to more than 11 per cent. After the year 2000, it starts to decline again. this is caused by much slower growth in the manufacturing sector. The pattern of growth of GDP under LGHF is the same LGLF will produce slightly faster growth due to a smaller number of population following from the faster fertility decline. The Reduction of population will increase per capita income which will increase level of consumption, and this in turn will increase GDP growth of sectors which are constrained by demand. However, the smaller number of population will reduce total consumption, which at the end will reduce growth of GDP in the same sectors. These opposing effects have resulted in a slight increase of GDP.

3. Growth of population

High growth of GDP will reduce fertility and since mortality is a function of GDP only during the period 1980-1990, population growth will also be slower. This can be seen in Table V.12. under HGHF and LGHF. Population growth during 1980-1990 will accelerate due to faster decline in mortality affected by growth of GDP. With slower growth of mortality as exogenously given after 1990, population growth rate start to decline from 2.48 per cent in 1990 to 2.05 per cent in 2010. The pattern of growth of population under HGHF and LGHF is similar, however, overall the growth under HGHF is slower.

If fertility declines as projected by the Government, a consistant decline in population growth will be obtained. The growth rate declines from 2.26 to 1.07 per cent during the period 1980-2010. A quicker decline

Table V.11. Projection of GDP under three assumptions
(Billions of Rps. at 1973 prices)

Year	HGHF	LGHF	LGLF	Rate of annual increase (Percentages)		
				HGHF	LGHF	LGLF
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1979	9 963.8	9 963.8	9 963.8	–	–	–
1980	10 774.1	10 774.1	10 774.1	8.13	8,13	8.13
1981	11 670.1	11 646.7	11 643.9	8.32	8.10	8.07
1982	12 704.7	12 636.5	12 632.1	8.86	8.50	8.49
1983	13 935.5	13 813.9	13 810.1	9.69	9.32	9.33
1984	15 387.8	15 216.6	15 215.6	10.42	10.15	10.18
1985	17 061.3	16 844.9	16 847.2	10.86	10.70	10.72
1990	29 241.8	28 304.3	28 328.7	11.38	10.94	10.95
1995	52 478.7	48 241.3	48 379.6	12.41	11.25	11.30
2000	93 803.3	82 338.1	80 647.6	12.32	11.28	10.76
2005	172 576.6	133 961.0	131 798.4	12.97	10.22	10.32
2010	335 350.5	218 925.9	215 316.3	14.21	10.32	10.31

Notes: HGHF = High Growth of GDP and High Fertility
LGHF = Low Growth of GDP and High Fertility
LGLF = Low Grwoth of GDP and Low Fertility.

Table V.12. Projection of population under three assumptions
(in thousands)

Year	HGHF	LGHF	LGLF	Rate of annual increase (Percentages)		
				HGHF	LGHF	LGLF
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1979	144 226	144 226	144 226	–	–	–
1980	147 490	147 490	147 490	2.26	2.26	2.26
1981	150 990	150 990	150 692	2 37	2.37	2.17
1982	154 572	154 572	153 963	2.37	3.37	2.17
1983	158 239	158 239	157 306	2.37	2.37	2.17
1984	161 994	161 994	160 721	2.37	2.37	2.17
1985	165 838	165 838	164 210	2.37	2.37	2.17
1990	187 453	187 628	182 952	2.48	2.50	2.18
1995	211 026	211 943	201 168	2.40	2.47	1.92
2000	235 505	238 126	217 908	2.22	2.36	1.61
2005	260 908	266 447	232 537	2.07	2.27	1.31
2010	288 820	300 157	245 303	2.05	2.41	1.07

Notes: HGHF = High Growth of GDP and High Fertility
LGHF = Low Growth of GDP and High Fertility
LGLF = Low Growth of GDP and Low Fertility.

in fertility as recently targeted by the Government (50 per cent decline during the period 1970-1990) will, consequently, produce a much slower population growth. However, this is not simulated here due to no indication that the past experienced decline may lead to this rapid decline of fertility.

During the period 1980-2010, the three simulations give substantial differences in the size of population. In the year 2010, the lower growth of GDP will increase the number of population by about 12 millions people. However, over shorter periods the difference is very small. The reduction in fertility will markedly reduce the total number of population. Even under low growth of GDP, with faster fertility decline, the total number of population in the year 2010 will be only 245 million people. This means, a reduction of about 55 million as compared to projection under LGHF.

4. GDP and employment in agriculture

The faster growth of GDP will speed up the process of industrialization. As can be seen in Table 15, the share of agriculture in GDP will rapidly decline such that is the year 2010 will be around 4 per cent. While in 1980 the figure is still more than 31 per cent. Under low growth, the declining process of the share of agriculture is slightly slower. The percentage of value added in agriculture will decrease to 5.6 per cent in the year 2010. This is around 1.5 per cent larger than the percentage under high growth. The process of industrialization is a little quicker when population growth is slower. With low growth of GDP under more rapid fertility decline, the contribution of GDP will reduce to 5.24 per cent.

The differences in the distribution of employment under the three projections is more prominent than differences in the distribution of value added. Under high growth, employment in agriculture will rapidly decline from around 63 to 22 per cent during 1980-2010. While the decline under low growth is only to about 34 per cent during the same period. The effect of lower fertility on the sectoral distribution of employment is favourable. Under the same conditions of GDP growth, a faster decline of fertility will reduce the percentage of employment in agriculture. The percentage of employment in agriculture under LGLF declines slightly faster than under LGHF.

Slower growth of GDP will slow down the transfer process from agriculture to non-agriculture. In turn

Table V.13. Projection of GDP and employment in agriculture under three assumptions (percentages)

Year	YAGR			EAGR			yagr/ynag		
	HGHF	LGHF	LGLF	HGHF	LGHF	LGLF	HGHF	LGHF	LGLF
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1979	32.79	32.79	32.79	–	–	–	0.00	0.00	0.00
1980	31.26	31.26	31.26	63.99	63.99	63.99	0.26	0.26	0.26
1981	30.05	30.00	30.00	63.39	63.41	63.41	0.25	0.25	0.25
1982	28.76	28.70	28.70	62.70	62.77	62.77	0.24	0.24	0.24
1983	27.37	27.29	27.29	61.90	62.01	62.01	0.23	0.23	0.23
1984	25.97	25.83	25.83	60.99	61.14	61.13	0.22	0.22	0.22
1985	24.61	24.41	24.41	60.03	60.19	60.19	0.22	0.21	0.21
1990	18.59	18.32	18.33	54.40	54.91	54.97	0.19	0.18	0.18
1995	14.05	13.92	13.97	47.63	49.21	49.23	0.18	0.17	0.17
2000	10.69	11.37	11.16	41.00	43.84	43.95	0.17	0.16	0.16
2005	6.84	7.98	7.65	32.99	39.24	38.28	0.15	0.13	0.13
2010	4.18	5.60	5.24	22.44	34.34	31.57	0.15	0.11	0.12

Notes: HGHF = High growth of GDP and High Fertility
LGHF = High Growth of GDP and Low Fertility
LGLF = Low Growth of GDP and Low Fertility.

slower growth of non-agriculture will reduce the amount of labour to be absorbed. More labour will, therefore, remain in agriculture. As ar result, *per capita* income in agriculture will decline. The *per capita* income in non-agriculture will also decline but the decline is relatively slower. This condition will result in the decline of the ratio of agricultural to non-agricultural income. Under high growth, this ratio will decline slowly from 0.26 to 0.15 during the period 1980-2010, and during the last 5 years (2005-2010) it stays constant. This will increase as there is no more labour surplus in agriculture. With a slower growth of GDP (under LGHF), the ratio of agricultural to non-agricultural income will decline faster to become 0.11 to 2010. However with slower fertility the ratio will decline only to 0.12 in the same year, since lower fertility will reduce the labour force.

5. Labour force

A lower growth of GDP will slow down fertility decline, increase population growth and consequently speed up the entrance into labour force. If there are no fertility measures, lower growth of GDP will be accompanied by unfavorable conditions of the population and a labour force. Their numbers are greater while the capacity to absorb is smaller, since the growth of GDP is smaller. This can be seen in Table V.14. Under lower growth (LGHF) the labour force will increase slightly faster as compared to those under high growth (HGHF).

If fertility measures are taken and fertility is to decline by 50 per cent during 30 years period (1970-2000) then conditions become more favorable. At the beginning the labour force increase will accelerate, but it achieve a high level only at 2.34 per cent compared to 2.48 per cent under high fertility. Moreover the rate of increase of labour force start to decline earlier (in the year 2000) compared to those under high fertility (which will start to decline only in the year 2005).

6. Investment and savings

Under low growth of GDP the rate of Government Saving will be higher. In the model Government saving is computed as the difference between Government revenue and expenditure. Government revenue is a function of GDP, while expenditure is a function of GDP and the previous years's expenditures. With lower GDP, the difference between revenue and expenditure (saving) is lower. However in percentage terms it increases. The Government seems to have a policy to maintain the level of savings to finance investment.

The rate of private saving will decrease with lower income. As can be seen in Table V.15., the growth of rate of savings will show down under LGHF as compared with HGHF. During 1980-2010 the saving rate will increase from around 11 to only 32 per cent, as compared to more than 39 per cent under HGHF. Under the same condition of growth, private saving is higher when fertility in lower. As evidence in Table V.15., the private saving rate under LGLF is higher as compared with LGHF.

More funds from abroad are needed when the economy is to grow fast. A larger percentage of foreign funds is required to maintain a high growth of GDP. As can be seen in Table V.16., the percentage of foreign funds over GDP is higher under HGHF compared with those under LGHF and LGLF. Moreover under high growth, foreign funds are required longer to supplement domestic saving for investment. Under HGHF, foreign funds are required by the economy until the year 2000, while under low growth only until 1995.

Table V.14. Projection of labour force under three assumptions
(in thousands)

	Labour force (1.000)			Rate of annual increase (Percentages)		
Year	HGHF	LGHF	LGLF	HGHF	LGHF	LGLF
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1979	0	0	0	–	–	–
1980	60 148.0	60 148.0	60 148.0	–	–	–
1981	61 476.7	61 476.7	61 472.3	2.21	2.21	2.20
1982	62 878.1	62 878.1	62 871.6	2.28	2.28	2.28
1983	64 323.3	64 323.3	64 316.6	2.30	2.30	2.30
1984	65 807.4	65 807.4	65 803.0	2.31	2.31	2.31
1985	67 344.8	67 334.8	67 344.8	2.34	2.32	2.34
1990	75 221.4	75 211.8	75 320.5	2.24	2.24	2.26
1995	84 156.5	84 147.2	84 253.3	2.27	2.27	2.27
2000	95 127.6	95 116.8	94 586.6	2.48	2.48	2.34
2005	107 985.1	108 050.1	105 840.9	2.57	2.58	2.27
1010	122 103.6	122 499.1	116 978.4	2.49	2.54	2.02

Notes: HGHF = High Growth of GDP and High Fertility
LGHF = Low Growth of GDP and High Fertility
LGLF = Low Growth of GDP and Low Fertility.

Table V.15. Projection of rates of government, private and domestic saving under three assumptions
(Percentages)

	HGHF			LGHF			LGLF		
Year	GS	PS	DS	GS	PS	DS	GS	PS	DS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1979	8.26	10.60	18.86	8.26	10.60	18.91	8.26	10.60	18.85
1980	8.89	11.10	19.99	8.90	11.10	19.99	8.90	11.10	19.99
1981	9.43	11.42	20.85	9.41	11.41	20.82	9.40	11.42	20.82
1982	9.95	11.78	21.73	9.90	11.75	21.65	9.89	11.77	21.66
1983	10.48	12.20	22.68	10.40	12.15	22.56	10.40	12.18	22.59
1984	10.99	12.68	23.68	10.92	12.61	23.53	10.92	12.66	23.58
1985	10.02	13.21	23.24	11.40	13.12	24.52	11.40	13.19	24.59
1990	10.57	16.34	26.91	13.14	16.06	29.19	13.14	16.28	29.41
1995	11.69	20.75	32.44	14.16	19.81	33.97	14.17	20.39	34.55
2000	10.76	25.18	35.94	14.55	23.52	38.07	14.46	24.33	38.79
2005	11.25	31.04	42.29	14.90	27.41	42.30	14.87	28.98	43.85
2010	11.56	39.18	50.74	15.06	31.91	46.97	15.05	34.68	49.74

Notes: HGHF = High Growth of GDP and High Fertility
LGHF = Low Growth of GDP and High Fertility
LGLF = Low Growth of GDP and Low Fertility.

Table V.16. Projection of source of fund for capital formation under three assumptions
(Percentages)

Year	HGHF			LGHF			LGLF		
	GS / GDCF	PS / GDCF	FF / GDCF	GS / GDCF	PS / GDCF	FF / GDCF	GS / GDCF	PS / GDCF	FF / GDCF
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1979	35.02	44.94	20.04	35.02	44.94	20.04	35.02	44.94	20.04
1980	38.08	47.51	14.41	38.92	48.57	12.52	39.02	48.69	12.29
1981	38.06	46.10	15.84	39.44	47.85	12.71	39.50	47.97	12.54
1982	36.62	43.38	20.01	37.71	44.78	17.52	37.66	44.82	7.52
1983	35.79	41.70	22.51	36.31	42.40	21.29	36.23	42.43	21.35
1984	35.99	41.54	22.46	36.16	41.77	22.07	36.09	41.86	22.05
1985	35.32	46.55	18.13	40.77	46.96	12.26	40.80	47.22	11.98
1990	33.31	51.50	15.19	44.99	54.02	1.79	44.23	54.79	0.98
1995	27.90	49.52	23.58	38.41	53.74	7.86	38.23	55.00	6.77
2000	28.92	67.64	3.44	50.47	81.56	–	49.66	83.58	–
2005	26.73	73.72	–	45.58	83.86	–	46.61	90.87	–
2010	24.17	81.93	–	45.49	96.38	–	46.73	107.66	–

Notes: HGHF = High Growth of GDP and High Fertility
LGHF = Low Growth of GDP and High Fertility
LGLF = Low Growth of GDP and Low Fertility.

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Part Two

A DEMOGRAPHIC-ECONOMIC MODEL FOR THE REPUBLIC OF KOREA: LONG-TERM DEMOGRAPHIC PROSPECTS AND POLICY IMPACTS

by

Sung-Yeal Koo
Korea Development Institute

Chapter VI

OVERVIEW OF THE MODEL

A second national demographic-economic model was constructed for the Republic of Korea. This study was intended to represent an Asian country at an intermediate level of economic and demographic development.

The model is composed of three major sectors; a demographic sector, a manpower sector and an economic sector. The demographic sector deals with the vital rates and the composition of population while the manpower sector deals with the level of educational attainment and the level of labour force participation of the population. In the economic sector, the size and composition of Gross National Product and employment are determined. The flow chart of the model is given in Figure VI.1. The notation of the variables used and their data sources are described in Appendix I. The order of computation is summarized in Appendix II.

A. DEMOGRAPHIC SECTOR

Life expectancies at birth (e_o^f), estimated as a function of *per capita* income level (PCY), determine the level of survival rates by age and sex ($Q_{a,s}$). Given the survival rates, the size of fecund age (15-44) female population and their age specific fertility rates ($AFR_{a,g}$) determine the total number of births (BTH_s). Age specific fertility rates are determined by exogenously given levels of total fertility rates (TFR_g) and by endogenously determined levels of the mean age at child birth (ACB_g). The levels of the latter (ACB_g) are determined by the educational attainment level of the population ($EDU_{a,s,g}$) as well as the level of *per capita* income.

Given the size of births (BTH_g) and deaths (DTH_g) by region, the size of total population by age and sex is determined after eliminating exogenously given number of emigrants by age and sex ($EMI_{a,s}$). The urbanization rate (URB), estimated as a function of average productivity of labour (APL), determines the size of urban population. Exogenously given levels of age-sex specific migration propensities ($m_{a,s}$) then determine the size of migrants by age and sex ($MIG_{a,s}$).

With the size of population given by age, sex and region ($POP_{a,s,g}$), family size by region (FMS_g), estimated as functions of time and the levels of fertility rate, determine the age composition of the family ($FMS_{a,g}$).

B. MANPOWER SECTOR

The rates of secondary school enrolment (ENR) and graduation (EDU_{18}) are determined as functions of *per capita* income level and the age composition of population.[1] The sex - and region-specific high school graduation rates of population age 18 ($EDU_{18,s,g}$) are obtained by decomposing the estimated graduation rate (EDU_{18}) into different sexes and regions according to the time trends of the urban-rural gap and the intra-regional male-female gaps in terms of educational attainment. The graduation rates thus obtained are assumed to be carried over successively throughout the life span of the relevant age-sex cohort.[2]

The manpower sector also determines the labour force participation of the population. Labour force participation rates ($LFR_{a,s,g}$) are determined as functions of the age and average productivity of labour for the male population and as functions of the age, the fertility level and the school enrolment of the relevant population for females. The size of the economically active population ($LFS_{a,s,g}$) is determined by applying the rates to the relevant population, net of exogenously-given sizes of institutional population (such as soldiers).

C. ECONOMIC SECTOR

The composition of GNP is considered both on the expenditure side and the production side (VAD_i). The size of GNP is determined by expenditure, and once the expenditure components are known, the composition of output by productive sector is determined.

On the expenditure side, GNP is composed of private consumption (CON_p), government consumption (CON_g), investment (GCF), and the balance between total exports (XPT) and total imports (MPT). The size of GNP is determined simultaneously with the size of these components. Private consumption is a function of GNP and its own, past level all measured in terms of *per capita* adult units. Government consumption

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1 Defined as the ratio of the eligible age population over the adult age population, it measures the burden borne by the society to educate its children.

2 The implicit assumptions are that the differentials due to educational level in mortality and the migration propensities are negligible.

is proportional to private consumption. The investment rate (GCFR), which is given exogenously as a policy variable, determines the size of total investment. The over-all balance of payment (BOP) is determined by an exogenously given trend of its ratio of GNP (BOPR). Given the size of GNP and these components, total imports are projected as a function of *per capita* land size, population and the level of *per capita* income. Total export is then derived by adding total balance of payment to total import.

Given the size and composition of total expenditure, a matrix converts them into value added by five productive sectors or industries; agriculture, light manufacturing, mining and heavy manufacturing, social overhead capital (SOC) and other services. Each element of the matrix is extrapolated non-linearly by a time trend.

The demands for labour by industrial sector (LFD_i) are obtained by dividing industrial value added by trend values of industrial productivity of labour (APL_i). The size of total employment (EMP) is determined by the demand (LFD)-supply (LFS) condition of the labour market. Actual employment in each sector is determined by its share in labour demand. Industrial employment is subdivided regionally (i.e. urban and rural) according to a cross-sectionnally given pattern of regional employment. Finally, the levels of average productivity of labour for each industry (APL_i) are adjusted according to the actual level of employment and regional productivity is obtained as an average weighted by the industrial employment structure.

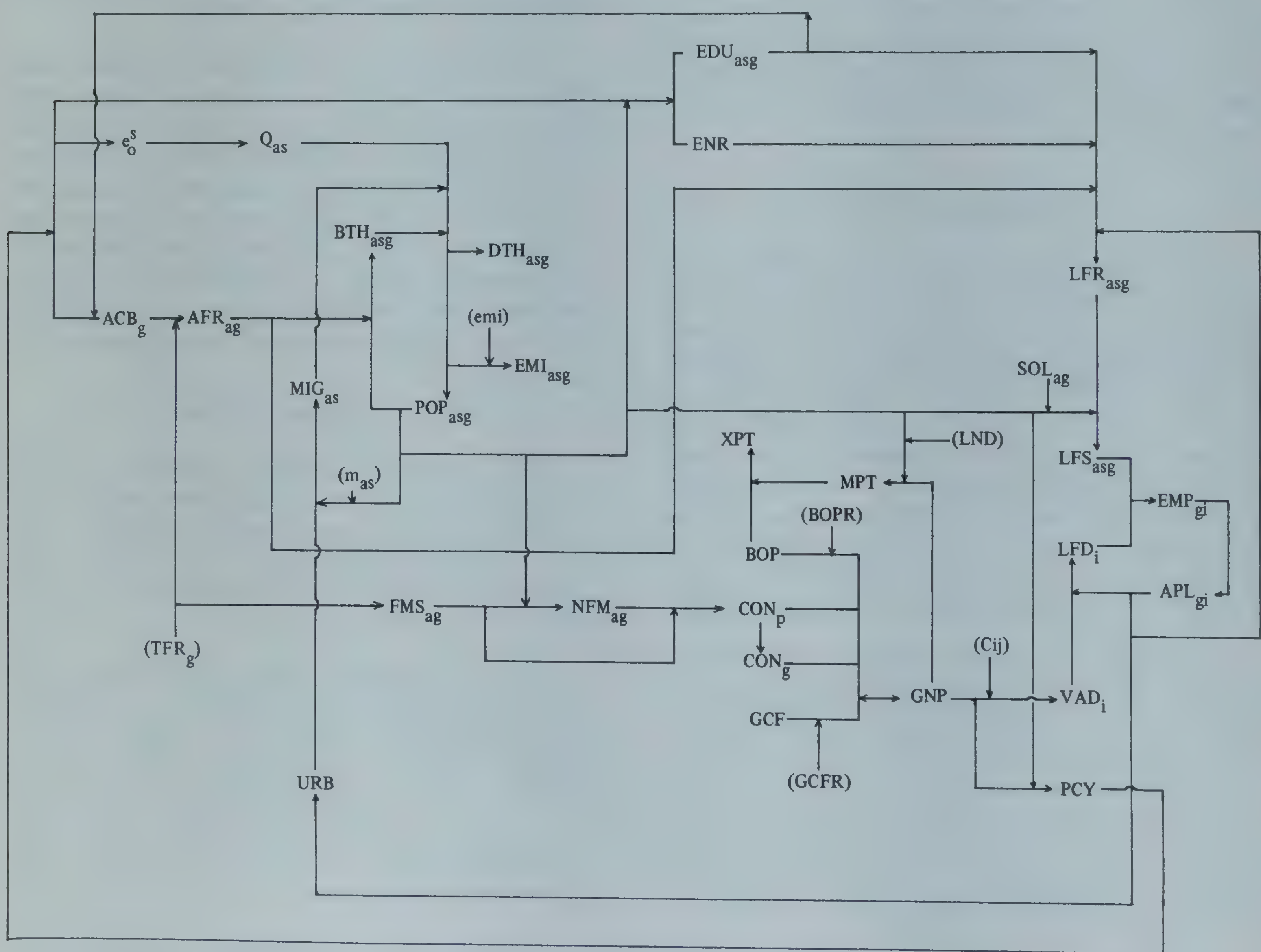

Figure VI.1. Flow chart of the model

Chapter VII
ESTIMATION OF THE MODEL

A. DEMOGRAPHIC SECTOR

1. Life expectancies at birth and the survival of population

(a) The female life expectancy at birth (e_o^f)

Female life expectancy depends on the level of income and the extent to which health and medical services are available. Although the level of individual income and the availability of medical services are very closely related, some services are available irrespective of the level of individual income, via government subsidies or foreign aid. Assuming that such non-income factors grow consistently over time,[3] the level of the female life expectancy at birth is specified as a function of the *per capita* income level and time.

Owing to the scarcity of the Korean data, available data of Japan and Taiwan were pooled but no country dummies were included. It is assumed that the differentials in terms of the pattern of female life expectancy are negligible among the countries. A cubic spline functional form is used to follow the pattern closely but a ceiling of 77.5 years is assumed. The numbers in parenthesis under the estimated coefficients are standard errors.

$$\ln(77.5 - e_o^f) = 4.8913 - \underset{(0.097)}{0.34738X} + \underset{(0.107)}{0.07435X^2D_2}$$

$$- \underset{(0.095)}{0.25835X^3D_2}$$

$$+\underset{(0.042)}{0.040687[(X-0.5)^3D_1D_2 + (0.75X - 0.125)(1-D_2)]}$$

$$- \underset{(0.0017)}{0.038783(T-1900)}$$

$R^2 = 0.9846$, $n = 40$

$X = 0.5735$ PCY–1: 0.5735 is a price conversion coefficient (1970 into 1975)

$D_1 = 1$ if $-0.5 < X \leq 0$, $D_2 = 1$ if $X \leq 0$

(b) Survival rates ($Q_{a,s}$) and the male life expectancy (e_o^m)

There seems to be a very close relationship between male and female life expectancies at birth. This is very apparent in the model life tables. For Japan and Taiwan, the ratio of the male to the female life expectancy is around 0.93.[4] But a recent demographic survey in Korea (BOS, 1980) revealed that the ratio stood at 0.91 during the 1978-1979 period survey[5] are compared with those from the comparable levels of the Western Model Life Tables. Unlike the female mortality rates which are somewhat close in pattern to the model life table, the male mortality rates are noticeably higher for the ages 40 and above. Comparable levels of the model life tables range from 20.6 to 15 up to age 60, but for the ages 60 and over, the range is even wider.

For the above reasons, survival rates are derived from the life tables of Korea prepared by the Bureau of Statistics.[6] Both the age specific survival rates and the male life expectancy were approximated by linear interpolation using as a parameter the female life expectancy at birth estimated above.

$$Q_{a,s} = Q_{a,s}^L + (Q_{a,s}^{L+1} - Q_{a,s}^L)\frac{e_o^f - e_o^{f,L}}{e_o^{f,L+1} - e_o^{f,L}}$$

$$e_o^m = e_o^{m,L} + (e_o^{m,L+1} - e_o^{m,L})\frac{e_o^f - e_o^{f,L}}{e_o^{f,L+1} - e_o^{f,L}}$$

$e_o^L \leq e_o < e_o^{L+1}$: L is the corresponding life table level.

(c) Population age 1^+

Given the survival rates for 5-year age intervals, the mid-year population age 1^+ in the absence of migration is derived by applying a geometric mean of the survival rates of past and current years.

$$POP_{a,s,g,t} = POP_{a-1,s,g,t-1} \cdot (Q_{a,s,t-1} \cdot Q_{a,s,t})^{0.1}$$

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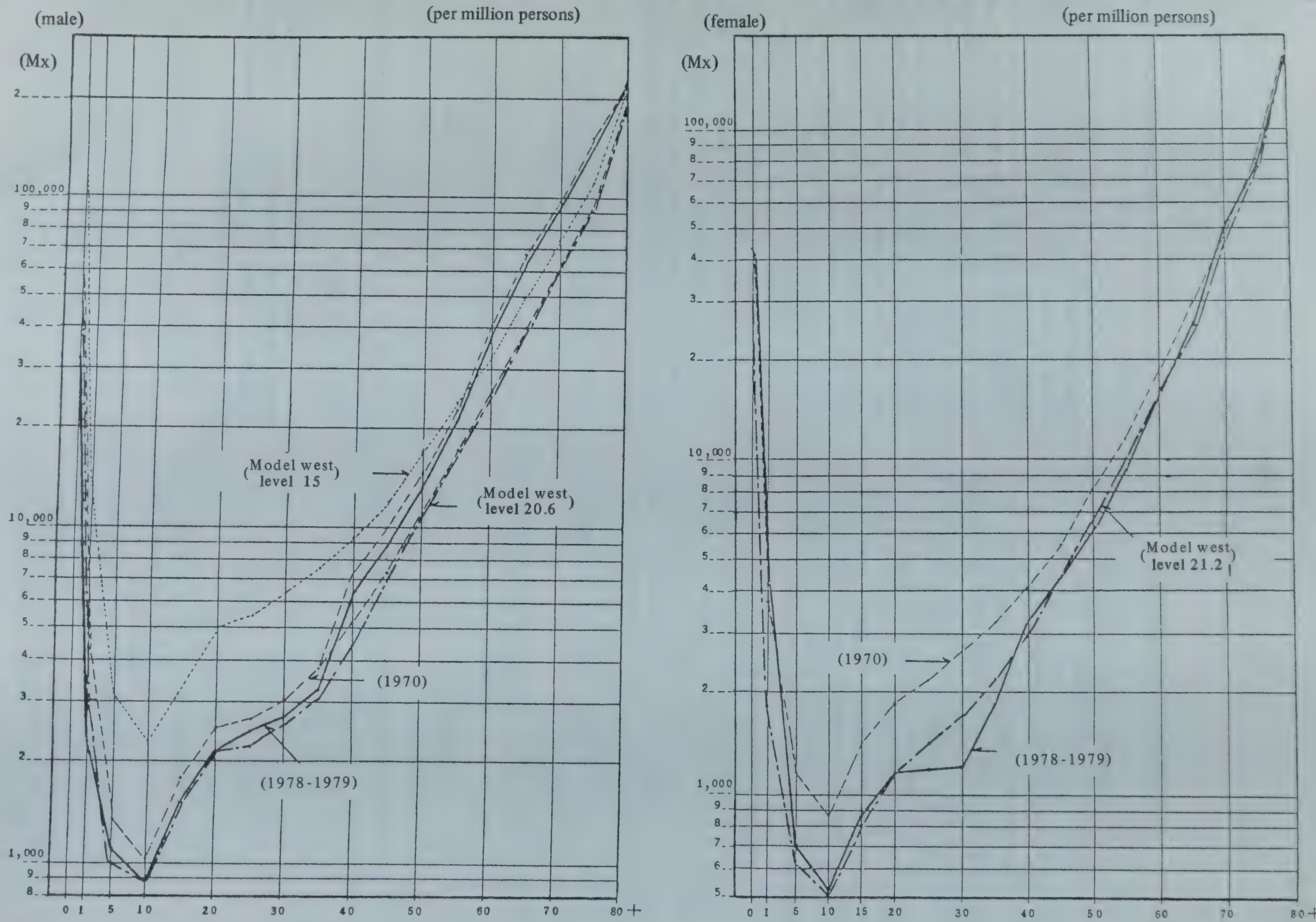
3 By assuming this, we do not include any public health policy variables into the picture. Since data on mortality is very scarce in Korea, it is very difficult to estimate the governmental impacts on mortality.

4 See the Appendix table 1.

5 See the Appendix table 2.

6 See the Appendix table 3.

Figure VII.1. Adjusted age specific death rates, 1978-1979



Source: BOS, 1980, pp. 20-21.

2. Fertility and the population age below 1

(a) Total fertility rate (TFR_g)

Although it is agreed that the Korean family planning programme was a great success, no estimates are readily available about the impact of the government inputs on the fertility of Korean women.[7] Thus, the total fertility rate is simply assumed to be a function of time and is estimated using the time series data since 1966, after which the programme became fully fledged. The reason for not including earlier data is in order to pick up as much of the impact of government input as possible by the time variable, so that an extrapolation of its trend line might imply the result from the continuous implementation of the programme. However, a floor is assumed as the limit of the trend at the level of two[8] and a rural dummy is inserted to have more consistent regional estimates.[9]

$$\ln(TFR_g - 2) = \underset{(0.837)}{6.86119} + \underset{(0.0873)}{0.668153}D_r - \underset{(0.0116)}{0.0925494}(T-1900)$$

$R^2 = 0.853 \qquad n = 24 \qquad D\text{-}W = 1.49$

[7] The following equation was estimated by since the estimated coefficients were not significant it was not applied here.

$$\ln(TFR_g - 2.0) = 0.628425 + \underset{(0.472)}{0.429781}\,D_r - \underset{(0.326)}{0.594008}\ln PCY_{t-1} + \underset{(0.416)}{0.340301}\ln TFR_{t-1} - \underset{(0.025)}{0.014029}\ln FMP_{t-1} - \underset{(0.265)}{0.04552}\ln EDU_{t-1}$$

$R^2 = 0.930 \qquad n = 30 \qquad D\text{-}W = 1.962$

where FMP_{t-1} and EDU_{t-1} are *per capita* family planning expenditure and the proportion high school graduates for women age 20-44. D_r is a rural dummy. The so called marriage squeeze which seems already prevalent in the country was not allowed in this model since it leads to the additional equations on proportion married and age at marriage and so on for which the current data are not available.

[8] In view of the Japanese experience, the floor may become lower but considering the difference in the family system between the two countries, the level of two seems to be reasonable.

[9] Insertion of rural dummy not only saves the limited degree of freedom in the estimation but also results in the estimates of the regional TFR's which converge over time toward the given lower limit. The rural-urban differential decreases systematically over time.

(b) Mean age at child birth (ACB_g)

Given the age specific fertility rates, the mean age at child birth is defined as,

$$ACB = \sum_a a \cdot (AFR_a / TFR)$$

However, since age specific fertility rates are not known, an initial set of the regional mean ages at child birth ($\breve{ACB}_g$) are estimated by a function which relates them to the proportion graduated from high school of the women age 20 to 44, the level of *per capita* income and their own past trends, all lagged by a year. As in the TFR equation, a floor is assumed at the level of 27 and a rural dummy is inserted.

$$\ln(\breve{ACB}_g - 27) = 4.65019 + \underset{(0.324)}{0.523887}D_r - \underset{(0.309)}{1.39057}\ln PCY_{t-1} + \underset{(0.176)}{0.134464}\ln EDU_{t-1}^{f,20\text{-}44} - \underset{(2.474)}{1.53694}\ln ACB_{t-1}$$

$R^2 = 0.891 \qquad n = 28$

(c) Age specific fertility rates ($AFR_{a,g}$)

Given the levels of total fertility rate and the mean age at child birth, age specific fertility rates may be derived from the Brass equation (Brass, 1968).[10] But its application to the Korean data tended to grossly overestimate the fertility of the youngest (15-19) age group and underestimate the fertility of the most fecund (25-29) age group.

Recently, Mason[11] estimated the age pattern of the fertility of Korean women using the same parameters. The results obtained seem reasonably good and are directly applied here. His method can be summarized stepwise: (i) A cumulative fertility distribution within the age interval of 20 to 40 is estimated as a cubic logistic spline function of age, the mean age at child birth and the total fertility rate. A density function derived from the distribution function, denotes for each age the proportion of the age specific fertility over the total fertility. Thus, age specific rates within the all interval are obtained by multiplying the density function

[10] $AFR_a = (TFR/99826.75)\ [0.25(ACB+14.8-a)^4 - 11(ACB+14.8-a)^3 - 0.25(ACB+19.8-a)^4 + 11(ACB+19.8-a)^3]$

[11] Andrew Mason, a research fellow of the East-West Population Institute.

to total fertility rate. (ii) For ages below 20, a square distribution is assumed and is set in such a way that it is continuous at age 20 and starts from zero at age 15. (iii) For ages above 40, a linear distribution function is assumed in such a way that it is continuous at age 40 and reaches 1 at age 45. His results are summarized in the following:

a. $20 \leqslant a < 40$:

$$AFR_{a,g} = TFR.f_{a,g}$$

$$f_{a,g} = (F_{a+1,g} - F_{a,g})D + 0.2\,(F_{40,g} - F_{35,g})\,(1-D)$$

$$D = 1 \quad \text{if} \quad a<35$$

$$F_{a,g} = [1 + \exp Z_g\,(\ln TFR_g - 3.5)]^{-1}$$

$$\begin{aligned} Z_g = &-0.57841 + 4.5206X_g + 3.5155X_g^2 \\ &+ 0.037605X_g^2 \cdot \widehat{ACB}_g + 131.66X_g^3 \\ &+ \left\{-163.17X_g^3 + [74.124(X_g - 0.15)^3 \right. \\ &\left. -82.318(X_g - 0.3)^3 D_3]\, D_2 \right\} D_1 \end{aligned}$$

$$X_g = a/\widehat{ACB}_g - 0.85$$

$$D_1 = 1 \quad \text{if } X_g > 0. \quad D_2 = 1 \quad \text{if } X_g > 0.15$$

$$D_3 = 1 \quad \text{if } X_g > 0.3$$

b. $a<20$

$$AFR_{a,g} = 0.04 \cdot (2a-29) \cdot F_{20,g} \cdot TFR_g$$

c. $a \geqslant 40$

$$AFR_{a,g} = 0.2 \cdot (1-F_{40,g}) \cdot TFR_g$$

With the fertility rates known, the actual level of mean age at child birth is adjusted.[12]

$$ACB_g = \sum_a a.(AFR_{a,g}/TFR_g)$$

---

12 The initial and the adjusted (ACB) levels showed a discrepancy of 0.5 years in age throughout the projection period:

		$\widehat{ACB}$	ACB	$\widehat{ACB}$–ACB
	1981	27.7	27.3	0.4
Urban	1990	27.4	26.8	0.6
	2010	27.1	26.5	0.6
	1981	28.0	27.6	0.4
Rural	1990	27.6	27.1	0.5
	2010	27.1	26.5	0.6

(d) Birth (BTH_g) and the population age below 1 ($\widehat{POP}_{0,s,g}$)

The number of children born between end-year points ($BTH_{g,t}$) and between mid-year points (BTH_g) are respectively defined as

$$BTH_{g,t} = \sum_{a=15}^{44} AFR_{a,g,t} \cdot \widehat{POP}_{a,f,g,t}$$

$$BTH_g = 0.5\,(BTH_{g,t-1} + BTH_{g,t})$$

The proportion of male children born is assumed to be 0.512 of the total number of children born. The mid-year population age below 1 is derived by applying the respective survival rate to each periodic birth cohort.

$$BTH_{m,g} = 0.512\ BTH_g \qquad BTH_{f,g} = 0.488\ BTH_g$$

$$\widehat{POP}_{0,s,g,t} = 0.5\,(BTH_{s,g,t-1} \cdot Q^{0.25}_{0,s,g,t-1} \cdot Q^{0.5}_{0,s,g,t} + BTH_t \cdot Q^{0.25}_{0,s,g,t})$$

3. Death (DTH_g) and the natural growth of population

The number of people dying between mid-year points (DTH_g) is derived as a residual:

$$DTH_g = POP_{g,t-1} + BTH_g - \widehat{POP}_{g,t}$$

CBR, CDR, and RNI are all defined in terms of the mid-year interval:

$$CBR_g = \frac{BTH_g}{\dfrac{(POP_{g,t-1} + \widehat{POP}_{g,t})}{2000}}$$

$$CDR_g = \frac{DTH_g}{\dfrac{(POP_{g,t-1} + \widehat{POP}_{g,t})}{2000}}$$

$$RNI_g = CBR_g - CDR_g$$

$$NRR_g = \prod_{a=0}^{45} Q_{a,f} \cdot [\cdot D + AFR_{a,g}(1-D)]$$

$$D = 1 \qquad \text{if } a<15$$

4. Migration ($MTG_{a,s}$) and the regional distribution of population

(a) Urbanization rate (URB)

According to Suits (1980), the proportion of the farm population over the total population is a function of labour productivity. Assuming that there is a close relationship between the proportion farm and the proportion rural population,[13] the proportion of rural population is regressed against the past level of the economy-wide productivity of labour.[14] In order to eliminate the effect of boundary changes, a similar equation was also estimated which included dummy variables for the years which had major boundary changes.[15] But the result is not utilized here since the boundary change can be also considered as a type of urbanization.

The urbanization rate equation is:

$$\ln(1-URB_t) = \underset{(0.0718)}{1.77085} - \underset{(0.0155)}{0.505249} \ln APL_{t-1}$$

$$R^2 = 0.987, \quad D\text{-}W = 1.4, \quad n = 16(1964\text{-}1979)$$

$$POP_{u,t} = POP_t \cdot URB_t$$

$$POP_{r,t} = POP_t \cdot (1-URB_t)$$

(b) Net internal migration ($MIG_{a,s}$)

The size of net internal migrants is derived as a residual:

$$MIG_t = POP_{r,t-1} + BTH_r - DTH_r - POP_{r,t}$$

Given the size of total migration, its age and sex composition is derived by assuming that recent relative migration propensities by age and sex (Table VII.1.) hold through time, except for the population age below 1. For migrants age below one, it is assumed to depend upon the fertility of the migrants as well as the mortality of the children born. The initial estimates thus derived are adjusted proportionately to the size of the total migrants.

[13] For the years of 1965, 1970 and 1975, the ratio between the proportion rural population to the proportion employed in agriculture stayed at levels around 0.879.

[14] A separate equation was also estimated which regressed the variable to the agricultural as well as the non-agricultural productivity but the differential productivity had eligible effect.

[15] The result is:

$$\ln(1\text{-}URB_t) = \underset{(0.238)}{1.11847} - \underset{(0.0548)}{0.354347} \ln APL_{t-1} - \underset{(0.0178)}{0.033121} D_{70} - \underset{(0.0176)}{0.0112364} D_{72} - \underset{(0.0198)}{0.0186237} D_{73} - \underset{(0.0179)}{0.016598} D_{74} - \underset{(0.0162)}{0.0304293} D_{78}$$

$$R^2 = 0.994, \quad D\text{-}W = 2.34, \quad n = 16$$

Table VII.1. Relative migration rates of rural population by age and sex

Female age 15 – 19 = 1.0

Age	Male	Female
0 – 4	0.1870	0.1868
5 – 9	0.2499	0.2364
10 – 14	0.3098	0.3236
15 – 19	0.8846	1.0
20 – 24	0.4510	0.8166
25 – 29	0.8711	0.6311
30 – 34	0.5896	0.3480
35 – 39	0.3552	0.2346
40 – 44	0.2293	0.1689
45 – 49	0.1534	0.1378
50 – 54	0.0678	0.1317
55 – 59	0.0589	0.1475
60 – 64	0.0395	0.1489
65+	0.0538	0.1139

Source: Kwon, 1975, pp. 60-61.

1. $a \geqslant 1$

$$\widetilde{MIG}_{a,s} = m_{a,s} \cdot \widehat{POP}_{a,s,r}$$

2. $a < 1$

$$MBTH_{m,t} = 0.512\, MBTH_t$$

$$MBTH_{f,t} = 0.488\, MBTH_t$$

$$\widetilde{MIG}_{0,s} = (MBTH_{t-1} \cdot Q^{0.25}_{0,s,t-1} \cdot Q^{0.25}_{0,s,t} + MBTH_t \cdot Q^{0.25}_{0,s,t})/2$$

3. $kt = MIG_t / \sum_a \sum_s \widehat{MIG}_{a,s,t}$

$$MIG_{a,s,t} = k_t \cdot \widehat{MIG}_{a,s,t}$$

(c) Number of emigrants (EMI) and the size and composition of regional population

With the rate of emigration (emi) exogenously given as a policy variable, age-sex-region specific populations are obtained by a set of indentities. The dependency ratio and the sex ratio are also defined by region.

$$EMI_{a,s,g} = POP_{a,s,g} \cdot emi^{16}$$

$$POP_{a,s,u} = (\hat{POP}_{a,s,u} + MIG_{a,s})\ (1-emi)$$

$$POP_{a,s,r} = (\hat{POP}_{a,s,r} - MIG_{a,s})\ (1-emi)$$

$$DPR_g = \frac{(POP_{14-,g} + POP_{65+,g})}{(POP_{15\text{-}64,g}}$$

$$SXR_g = \frac{POP_{m,g}}{POP_{f,g}}$$

5. Average family size ($FMS_{a,g}$) and the number of families (NFM_g)

The size of family depends on cultural and noncultural factors. Culturally, the traditional extended family system in the Republic of Korea seems to give way to the nuclear family system recently. Whether extended or not, family size depends on the fertility and the mortality of the family members. Under nuclear family system, nuptiality of the family also affects the size. Assuming that the transition from the extended to the nuclear family system is smooth over time, the average family size can be explained mostly by time and the level of fertility. The mortality and nuptiality factors can be safely assumed away since their recent changes are very small and their effects can be picked up by the included variables.

Various sources of data are available for the size of household in the Republic of Korea. The population census and the annual year-end counts are available as total enumeration while some surveys on urban and farm households are available as partial enumeration. But the discrepancies between different sources are substantial (Table VII.2.) and the data before 1966 seem to be unreliable.

Considering only the data after 1966, the census trends of average family size seem to be consistent with the survey trends, although a substantial discrepancy in the level is clearly noticeable. Thus, the basic trend lines were estimated from survey data but the levels were adjusted to those of the censuses using a census dummy. A rural dummy is also inserted and the equation is specified in double-logs:

16 The composition of emigrants is not identical to that of the remaining population in terms of age, sex and the region. It tends to be more selective than the composition of internal migrants. But since the size of total emigrants is relatively very small, the composition of the remaining population will be distorted only marginally by the assumption.

Table VII.2. Trends in average family sizes

Source	Census, year-end count of population			Household survey	
Year \ Region	Urban	Rural	Total	Urban	Rural
1960*	5.55	5.83	5.75		
1961	5.62	5.79	5.74		
1962	5.51	5.93	5.79		6.32
1963	5.58	6.00	5.86	5.56	6.39
1964	5.55	6.09	5.91	5.56	6.44
1965	5.51	6.13	5.91	5.56	6.29
1966*	5.11	5.70	5.49	5.56	6.22
1967				5.55	6.12
1968				5.54	6.02
1969				5.53	5.99
1970*	4.88	5.51	5.24	5.48	5.92
1971	5.04	5.80	5.45	5.40	5.83
1972	5.31	5.65	5.50	5.37	5.71
1973	5.17	5.78	5.49	5.26	5.72
1974	5.11	5.77	5.44	5.22	5.66
1975*	4.72	5.24	4.98	5.18	5.63
1976	4.95	5.41	5.17	5.12	5.54
1977	4.93	5.38	5.14	4.83	5.52
1978	4.86	5.27	5.05	4.73	5.38

Note: Year-end count of population during 1967 to 1969 are not available.

* Census years.

1 Annual Report on the Family Income and Expenditure Survey.

2 Report on the Results of Farm Household Economy Survey.

$$\ln FMS_g = \underset{(0.143)}{2.45561} - \underset{(0.00147)}{0.01111}(T-1900) - \underset{(0.00693)}{0.08329}D_c + \underset{(0.0116)}{0.09274}D_r + \underset{(0.0341)}{0.00596}\ TFR_g$$

$R^2 = 0.962$, D-W $= 1.36$, $n = 32$ (1966-1978)

D_c = census year dummy

The number of households and the typical age structure for each household are derived from the above as follows:

$$NFM_g = POP_g/FMS_g$$

$$FMS_{a,g} = POP_{a,g}/NFM_g$$

B. MANPOWER SECTOR

1. Education

As an indicator of the educational attainment of the Korean population, the proportion educated to high school level and above seems to be the best because the primary school education is almost universal for the growing generation.[17]

(a) Secondary school enrolment (enr)

The enrolment rate is estimated as a function of the population composition and the level of *per capita* income. The first term, defined as the proportion of eligible age (13-18) over adult age (20+) population, measures the relative burden of education with a given level of income. Pooled data with Japan is used in order to prevent extreme extrapolation but a ceiling is also set at 1.

$$\ln(1-enr) = \underset{(0.1697)}{-0.517014} + \underset{(0.122)}{0.672121}\ln\left(\frac{POP_{13\text{-}18}}{POP_{20+}}\right) - \underset{(0.0498)}{0.84053}\ln PCY_{t-1} - \underset{(0.1016)}{0.194449}D_J$$

$R^2 = 0.9935$, $n = 24$, $D\text{-}W = 0.934$

D_J = Japan dummy

(b) Proportion educated high school and above ($EDU_{a,s,g}$)

The proportion graduating from high school in a given year was estimated in a similar fashion, but the income variable was replaced by a trend variable (year) since most recent trends were explained better by doing so.[18]

$a = 18$

$$\ln(1\text{-}EDU) = \underset{(1.278)}{1.11217} + \underset{(0.255)}{0.0258019}\ln\frac{POP_{18}}{POP_{20+}} - \underset{(0.0069)}{0.0192901}\cdot\ln(T\text{-}1900)$$

$R^2 = 0.809$, $n = 15$, $D\text{-}W = 0.419$

The above estimate is decomposed into the region and sex specific ratio by the following equations which estimate the trends of the rural-urban differential and the female-male differential within each region. Since no time series data is available on this, the census cohort rates were used.[19]

$$\ln\left(1-\frac{EDU_r}{EDU_u}\right) = \underset{(0.105)}{0.86828} - \underset{(0.00161)}{0.021569}\,(T\text{-}1900)$$

$R^2 = 0.928$, $n = 16$, $D\text{-}W = 0.379$

$$\ln\left(1-\frac{EDU_{f,g}}{EDU_{m,g}}\right) = \underset{(0.351)}{3.94283} - \underset{(0.00536)}{0.068231}\,(T-1900) - \underset{(0.0586)}{0.54936}\,D_u$$

$R^2 = 0.896$, $n = 32$, $D\text{-}W = 0.411$

$$EDU_{18,u} = \frac{EDU_{18}}{\left[\frac{POP_{18,u}}{POP_{18}} + \left(\frac{EDU_{18,r}}{EDU_{18,u}}\right)\left(\frac{1-POP_{18,u}}{POP_{18}}\right)\right]}$$

$$EDU_{18,r} = \frac{EDU_{18}}{\left[\frac{1-POP_{18,u}}{POP_{18}} + \left(\frac{EDU_{18,u}}{EDU_{18,r}}\right)\left(\frac{POP_{18,u}}{POP_{18}}\right)\right]}$$

$$EDU_{18,g,m} = \frac{EDU_{18,g}}{\left[\frac{POP_{18,g,m}}{POP_{18,g}} + \left(\frac{EDU_{18,g,f}}{EDU_{18,g,m}}\right)\left(\frac{1-POP_{18,g,m}}{POP_{18,g}}\right)\right]}$$

$$EDU_{18,g,f} = \frac{EDU_{18,g}}{\left[\frac{1-POP_{18,g,m}}{POP_{18,g}} + \left(\frac{EDU_{18,g,m}}{EDU_{18,g,f}}\right)\left(\frac{POP_{18,g,m}}{POP_{18,g}}\right)\right]}$$

For the age 19 and above, the proportion educated to high school level and above is obtained as follows:

$a > 18$

$EDU_{a,s,r,t} = EDU_{a-1,\,s,r,t-1}$

---

17 See the Appendix table 4. Although the recent expansion in the quota of college students will have significant implications for the future manpower and industrial policies, the subject is not considered here.

18 Fertility or family size may be additional cost factors to the age composition. But the inclusion of these variables were not successful due to a high collinearity between the right hand side variables. The urbanization rate must also influence the dependent variable but it is not included here since the urban-rural distinction is allowed for more systematically in the next equation. The low D-W statistic indicates either misspecification or measurement error for the education variables in general. Of these, measurement error seems to be the main reason in that the educational level of the population is increasing and the administrative book-keeping system is gradually improved. However, no remedial procedure was taken here since the equation has only marginal importance in the model.

19 By using the census cohort rates, the estimates tend to be biased insofar as there are differential mortality and migration rates due to different educational attainment.

$$EDU_{a,s,u,t} = EDU_{a-1,s,u,t-1} \cdot \frac{(POP_{a,s,u,t} - MIG_{a,s,t})}{POP_{a,s,u,t}} + EDU_{a,s,r,t} \cdot \frac{MIG_{a,s,t}}{POP_{a,s,u,t}}$$

This assumes that mortality differentials in terms of educational attainment are negligible.

2. Economically active population

(a) Labour force participation rate ($LFR_{a,s,g}$)

Two sources of data are available on labour force participation of the Korean population: the population census and the annual report on the economically active population survey. The former provides detailed information on age-sex-region specific activity rates but is available only for every five years. Besides, seasonal effects are present since it is taken usually in the last quarter of the year. On the other hand, the survey provides relatively longer series of annual averages but is less detailed than the census. Thus, the census data[20] is used to estimate age-sex-region specific activity rates but the estimates are adjusted to be consistent with the survey activity rates.

a. The male

The age pattern of the male LFR has an inverted U-shape. But when converted into the 'logit' value, the pattern can be approximated by three linear segments (Figure VII.2.). Besides simplicity in estimation, the 'logit' conversion has the advantage of keeping the predicted values within the appropriate range (0 to 1).

A typical age pattern assumed is described in Figure VII.3. Two points are assumed to be constant irrespective of economic condition; a_0 near to the entering age and a_3 near to the retiring age. All the other ages are assumed to have varying activity rates depending on the economic condition. The curve is assumed to be continuous and its shift is assumed to be the function of the growth rate of the labour productivity;[21] for all sectors in the case of the urban and for the primary sector in the case of the rural population. The estimated results are:

Urban

$$\ln\left(\frac{LFR}{1-LFR}\right) = \underset{(0.0762)}{0.289336} + \underset{(0.0196)}{0.315758}X_1 + \underset{(0.2666)}{0.757779}\,\dot{APL}\,X_1 - \underset{(0.0136)}{0.011815}X_2$$
$$- \underset{(0.2519)}{0.70297}X_x - \underset{(0.2565)}{0.684345}D_{60+} - \underset{(0.3142)}{1.25058}D_{22.5,70} - \underset{(0.3238)}{1.13448}D_{27.5,70} - 0.1D$$

$R^2 = 0.980, \quad n = 44$

$$X_1 = (a - a_0)D_1 + (a_1 - a_0)\left[(D_2 + D_3) - \frac{a - a_2}{a_3 - a_2} D_3\right]$$

$$X_2 = (a - a_1)D_2 + (a_2 - a_1)\left(1 - \frac{a - a_2}{a_3 - a_2}\right)D_3$$

$$X_3 = \frac{a - a_2}{a_3 - a_2} D_3$$

$D_1 = 1$ if $a < a_1$, $D_2 = 1$ if $a_1 \leqslant a < a_2$

$D_3 = 1$ if $a \geqslant a_2$

$a_0 = 20, \; a_1 = 30, \; a_2 = 45, \; a_3 = 65$

D = Seasonal adjustment dummy

$D_{60+} = 1$ if $a > 60$

$D_{22.5,70} = 1$ if $T = 1970$ and $20 \leqslant a < 25$

$D_{27.5,70} = 1$ if $T = 1970$ and $25 \leqslant a < 30$

Rural

$$\ln\left(\frac{LFR}{1-LFR}\right) = -\underset{(0.0866)}{0.844238} + \underset{(0.0157)}{0.414226}X_1 + \underset{(0.1044)}{0.549658}\,\dot{APL}_1 \cdot X_1 + \underset{(0.0081)}{0.0161402}X_2$$
$$+ \underset{(0.2575)}{1.61805}X_3 - \underset{(0.1926)}{1.54526}D_{60+} - \underset{(0.2270)}{2.01028}D_{22.5,70} - \underset{(0.2377)}{1.32499}D_{27.5,70} - 0.15D$$

R^2 0.990, $n = 33$, $a_0 = 15$, $a_1 = 25$, $a_2 = 45$, $a_3 = 70$

---

[20] Results of the 1974 Special Employment Survey were also included in the data used.

[21] Since the dependent variable is in logarithms it is appropriate to represent the level of productivity in logarithms also. The first difference in the logarithm of labour productivity (i.e. its growth rate) was used in preference as it performed better in this equation. It clearly is correctly picking up cyclical effects in LFR.

Figure VII.2. The age pattern of male LFPR

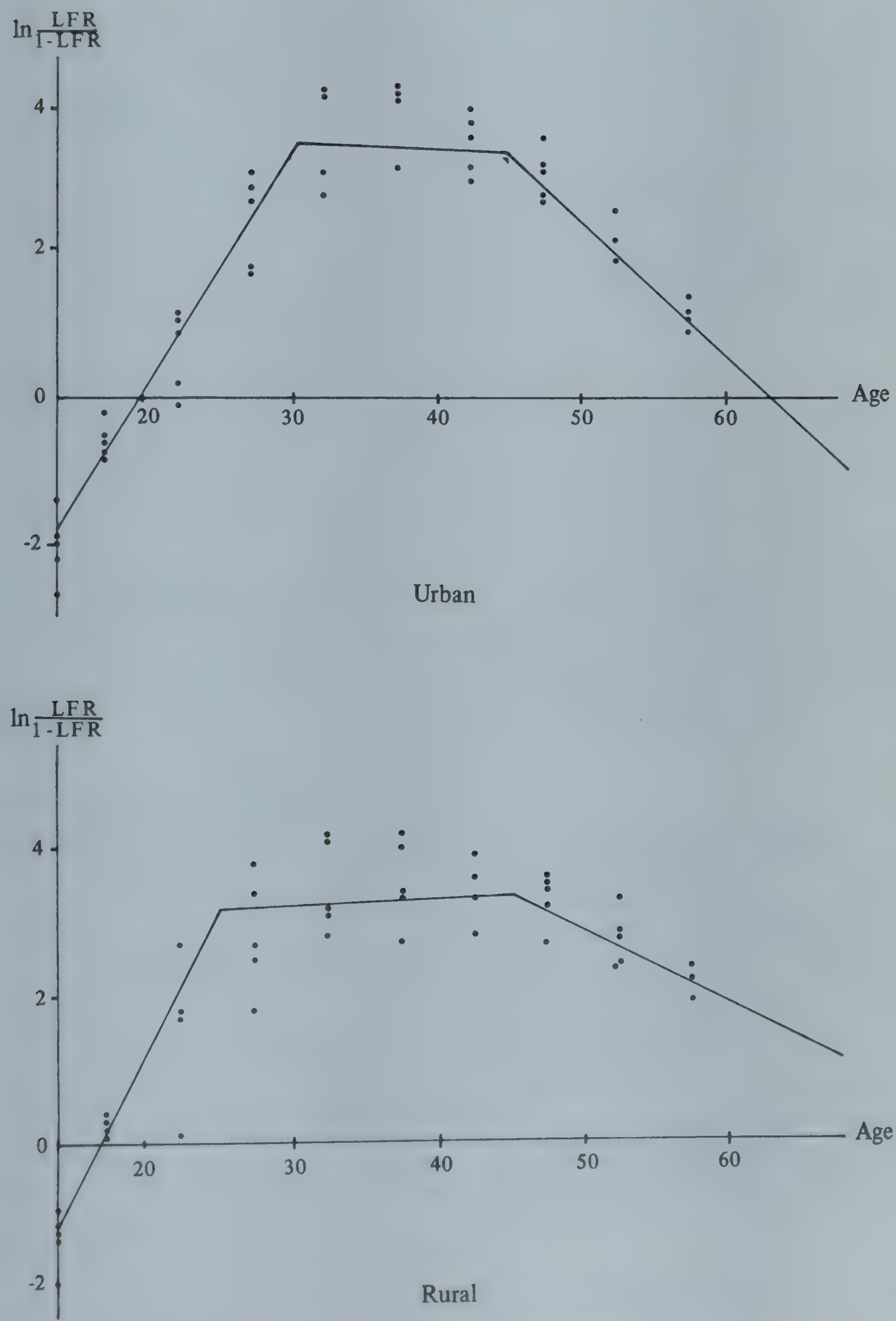
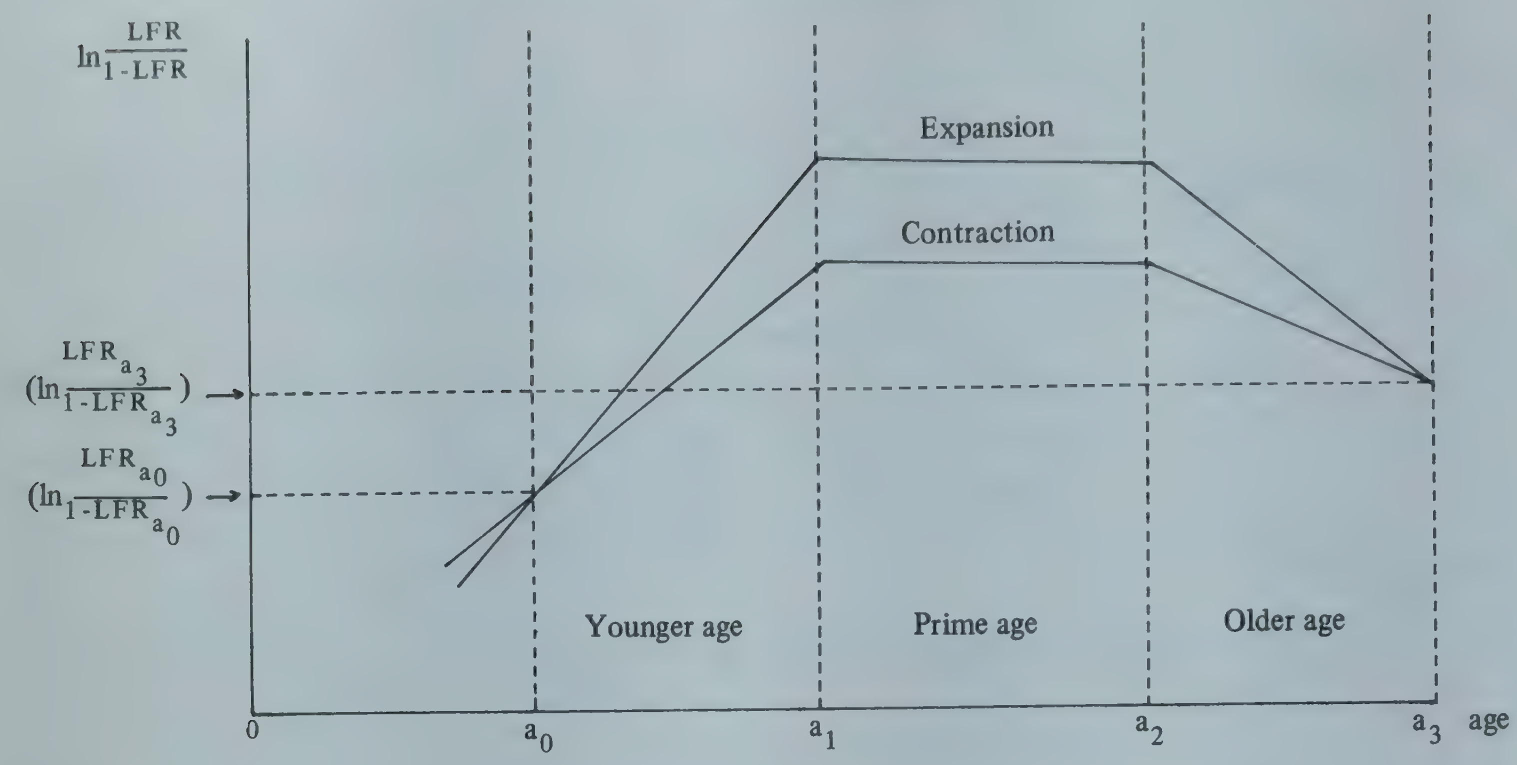


Figure VII.3. A typical pattern of male LFPR



b. The female

The age pattern of the female labour force participation rate is typically 'M-shape'. We assumed that this distinctive profile is due to the exclusive role of women for the bearing and raising of children. The female LFR is estimated by four different age categories by each region.

i. Age 20-44

Using the cumulative fertility rates derived from cross-section data as the proxy for the number of children ever born, a negative relationship seems to exist (see Figure VII.4) between the fertility and the labour force participation rate of the female population.[22] However, the pattern seems to be different between regions. While the urban participation rates show a set of parallel curves, the rural rates show a 'fan-shape' curves which share a common intercept but are different in slope. Thus, the urban rates are estimated mostly by intercept dummies while the rural rates are estimated mostly by using slope-dummies.[23]

[22] The discontinuities in Figure VII.4 arise from the inclusion of the 1974 Special Employment Survey.

[23] Since the constant terms are estimated to be positive, the estimated rates will be always positive. Unless an extremely high level of TFR is assumed the projected rate will stay within the range of 0 and 1.

Urban

$$(1-LFR_a) = \underset{(0.0286)}{0.6538} - \underset{(0.0082)}{0.0493}D_{74,75} - \underset{(0.0417)}{0.2376}D_{20-24}$$

$$+\underset{(0.0143)}{0.1243}D_{25-29} + \underset{(0.0113)}{0.1022}D_{30-34}$$

$$+\underset{(0.0105)}{0.0396}D_{35-39} + (\underset{(0.0068)}{0.0256} + \underset{(0.04)}{0.19}D_{20-24})TFR_a$$

$R^2 = 0.980$, $n = 25$, $D_{74,75}$ = Year dummy,

$D_{20-24} \cdots$ = Age dummy

Rural

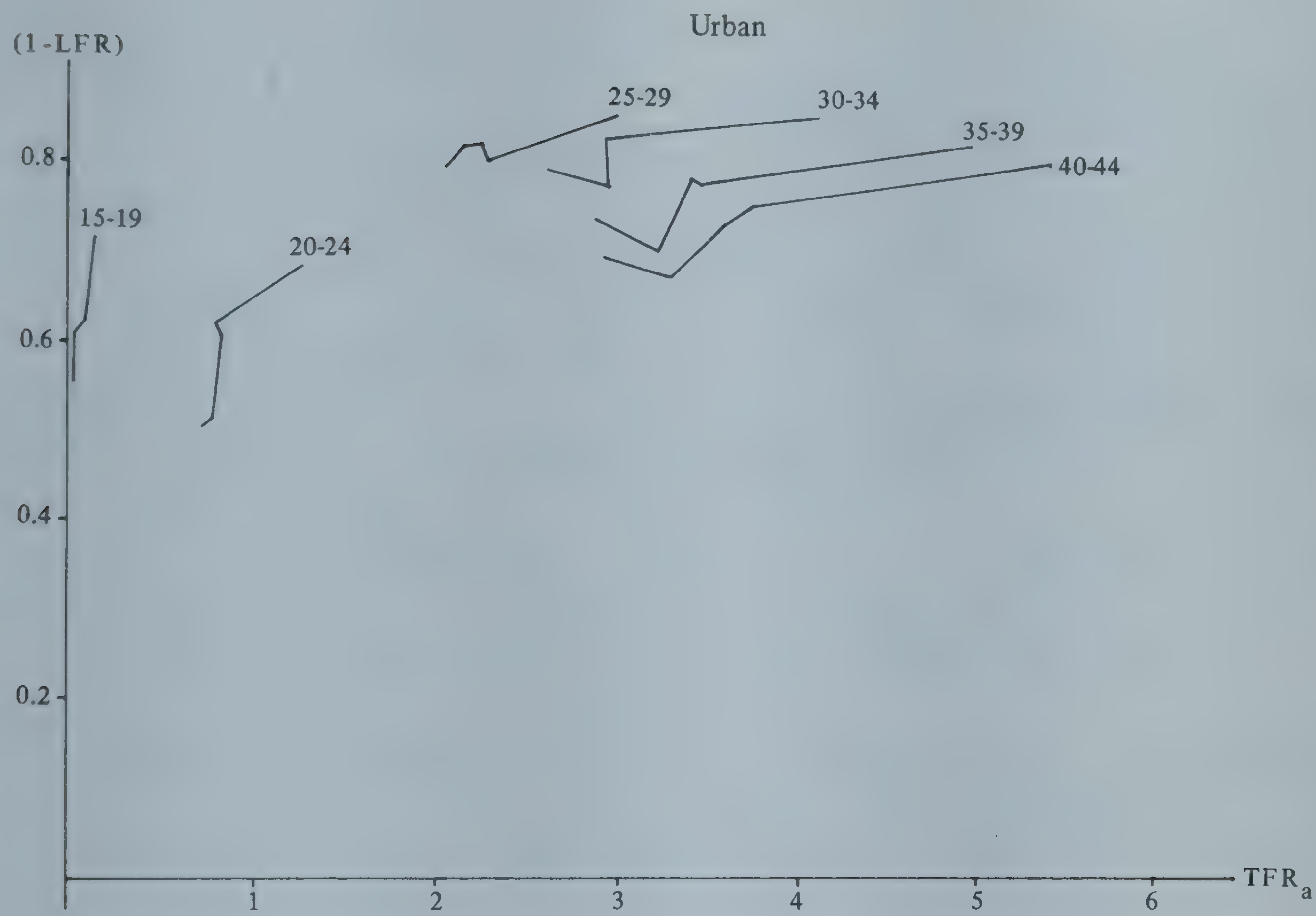
$$(1-\widehat{LFR}_a) = \underset{(0.028)}{0.085} - \underset{(0.01)}{0.1162}D_{74,75} + \underset{(0.063)}{0.1149}D_{25-29}$$

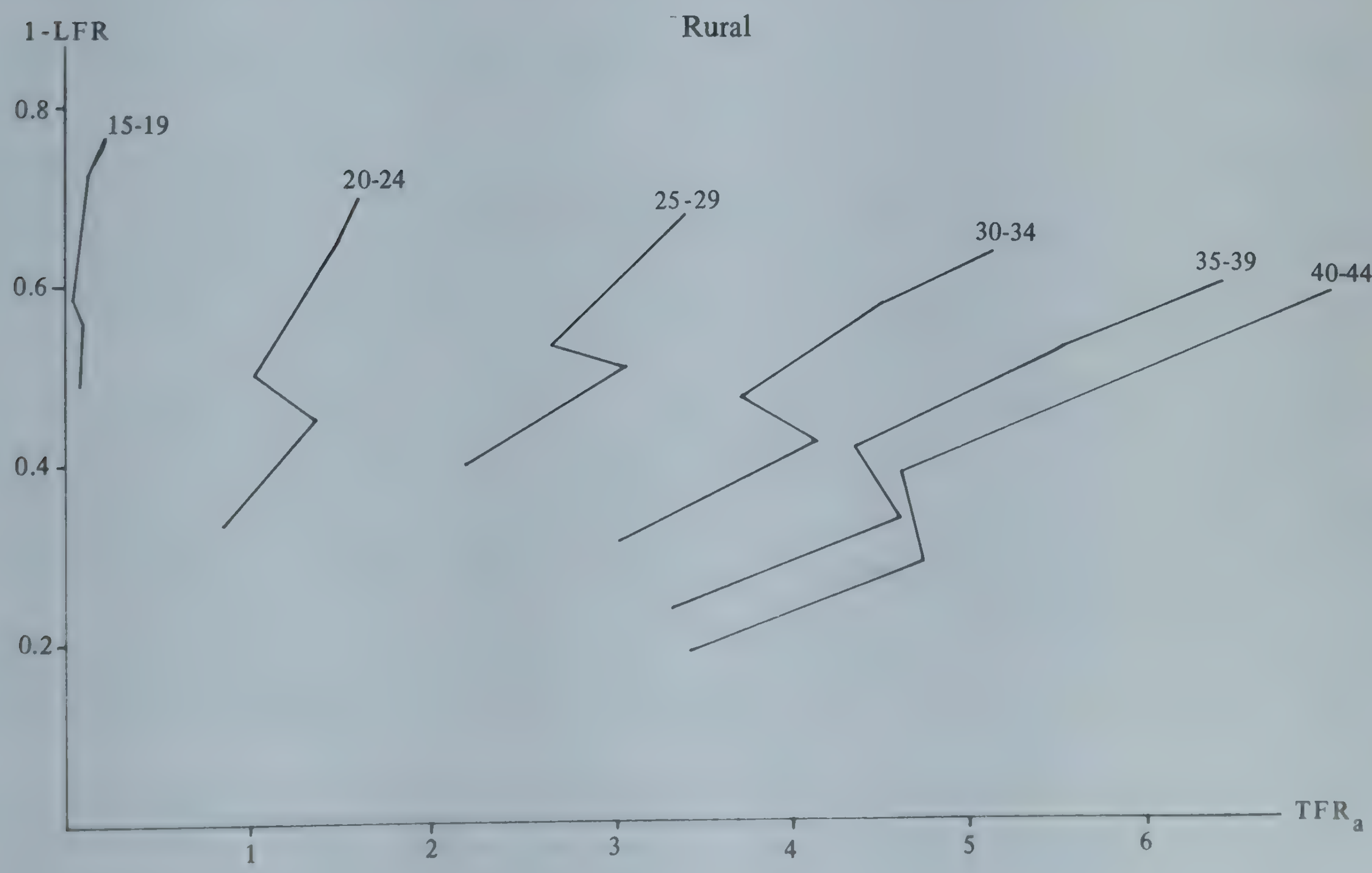
$$+(\underset{(0.005)}{0.0698} + \underset{(0.017)}{0.319}D_{20-24} + \underset{(0.002)}{0.0663}D_{25-29}$$

$$+\underset{(0.003)}{0.0393}D_{30-34} + \underset{(0.0025)}{0.0103}D_{35-39})\ TFR_a$$

$R^2 = 0.986$, $n = 25$

Figure VII.4. Cumulative fertility and LFR





ii. Other ages

For ages 45 and above, it is assumed that the curves are continuous at age 45. But for the urban population, it is assumed that the rate coverges to a fixed level at age 65 and the average rate for those age 60 and above stays at 0.059. On the other hand, the rural participation rates for these age groups are assumed to shift almost in parallel to that of age 45.[24]

For the age group 15-19, the labour force participation rates are estimated for each region as functions of fertility and school enrolment[25] of the relevant population. The rate at age 14 is assumed to be constant in urban areas but in rural areas it is assumed to be proportional to that of the 15-19 age group.

Urban

$$LFR^{45\text{-}60}_{a,f,u} = LFR^{40\text{-}44}_{u,f} + 0.006$$

$$\frac{a-47.5}{17.5}\,(LFR^{40\text{-}44}_{u,f} - 0.087)$$

$$LFR^{60+}_{f,u} = 0.059$$

$$LFR^{15\text{-}19}_{f,u} = 0.555 - 1.4809\ TFR_a - 0.222\ EDU_{18\text{-}19,f,u}$$

$$LFR^{14}_{f,u} = 0.175$$

Rural

$$\hat{LFR}^{45\text{-}60}_{a,f,r} = \tilde{LFR}^{40\text{-}44}_{r,t} - 0.004 - 0.036\ (D_{50\text{-}54} + 3.1528 D_{55\text{-}60})$$

$$\hat{LFR}^{60+}_{f,r} = 0.333\ \hat{LFR}^{55\text{-}59}_{f,r} + 0.042$$

$$\hat{LFR}^{15\text{-}19}_{f,r} = 0.7795 - 2.6879\ TFR_a - 0.4032\ EDU_{18\text{-}19,f,r}$$

$$\hat{LFR}^{14}_{f,r} = 0.5\ \hat{LFR}^{15\text{-}19}_{f,r}$$

[24] See the Appendix table 5.

[25] About 30 per cent of the students enrolled is assumed away as not eligible. The regression is done for the remaining population only. In the text, the enrolment rates are substituted by the graduation rates ($EDU_{18\text{-}19}$).

(b) Economically active population ($LFS_{a,s,g}$)

The size of economically active population is obtained by applying the above rates to eligible population by age, sex and region. For the male population, the 'institutionalized' population ($SOL_{a,g}$) of 750 thousand is assumed to be not eligible.[26] The rural female LFR's are uniformly adjusted by the mean difference between the census and the survey data.[27]

$$LFS_{a,m,g} = LFR_{a,m,g} \cdot (POP_{a,m,g} - SOL_{a,g})$$

$$LFS_{a,f,u} = LFR_{a,f,u} \cdot POP_{a,f,u}$$

$$LFS_{a,f,r} = (\tilde{LFR}_{a,f,r} - 0.045) \cdot POP_{a,f,r}$$

: 0.045 = mean difference between census and survey

C. ECONOMIC SECTOR[28]

1. The composition of GNP by expenditure sector

(a) Private consumption expenditure (CON_p)

The consumption function is estimated in two steps. Cross-section data were used to estimate the adult-equivalent units of consumption for four different age categories and the family size elasticity. Assuming that the estimates from the cross-section data hold over time, time-series data were used to estimate the consumption function in adult *per capita* units.

a. Family size elasticity and the adult equivalency units of consumption expenditure

From the 1978 Family Income and Expenditure Survey, annual average expenditures were derived for the 1,750 households which did not experience any change in their family composition and whose expenditures lay within one standard deviation from the average of the families of the same size.

An iterative method suggested by Prais-Houthakker (1971) is adopted but in order to avoid the divergency problem (Kim and Kim, 1975), the iteration process is divided into two partial loops: (i) one for the estimation of size elasticity and, (ii) another for the estimation of adult-equivalency units.

[26] Age specifically it is composed of: 15-19 (23), 20-24 (642), 25-29 (42), 30-34 (19), 35-39 (14), 40-44 (7), 45-49 (3), total (750 thousand). It is allocated to each region in proportion to the population size.

[27] For the male population, the estimated logit values are adjusted by lowering the intercept; 0.1 for the urban and 0.15 for the rural population.

[28] The rural-urban distinction is not rigorously pursued here since the data on Gross Regional Product are not available.

i. The size elasticity

In order to estimate the size elasticity, those households are selected which are composed of family members of age 14 and above only.[29] From this, an initial estimate of the size elasticity was obtained.

$$\ln C = \ln K + \theta \ln N_{a'}$$

$$= 13.276 + 0.601729 \ln N_{a'}$$

$R^2 = 0.480, \quad n = 293$

θ = Size elasticity

$N_{a'}$ = Family size (all adults)

The expenditure equations for each item are all specified as double-log. The initial estimate of θ is inserted in the equations to start the iterative loop.

$$\ln C_i = \ln K_i + \epsilon_i (\ln C - \theta \ln N_{a'}) + \theta_i \ln N_{a'}$$

ϵ_i = the Engel elasticity of the i-th expenditure item

θ_i = the size elasticity of the i-th expenditure item

A second estimate of the size elasticity ($\bar{\theta}$) is obtained by the weighted average of the size elasticities of the expenditure items (θ_i).

$$\bar{\theta} = \sum_i \theta_i \frac{C_i}{C}$$

The above estimation proceeded iteratively until θ and $\bar{\theta}$ were identical up to five decimal points. The result is shown in Table VII.3.

ii. Estimation of the adult equivalent units

In order to estimate the adult equivalent units, the sample was extended to cover all households. To shorten the iterative procedure, a set of average adult equivalent units (U_a) were estimated initially by the following equation.

$$(C/k)^{1/\theta} = \sum_a U_a N_a \quad [30]$$

Given the estimates of the elasticities (θ, θ_i, ϵ_i, k_i) and the initial estimates of $U_{a's}$ an iterative process is initiated to estimate $U_{a's}$ for each expenditure item (i).

$$\left[\frac{C_i \left(\sum_a U_a N_a\right)^{\theta \epsilon_i}}{k_i \; c^{\epsilon_i}} \right]^{1/\theta_i} = \sum_a U_{ai} N_a$$

Since the U_a is a weighted average of $U_{ai's}$, iterative estimation was continued between the above and the following equation until $U_{a's}$ in the above equation converged to the following average up to four decimal points in terms of the standardized units.

$$\bar{U}_a = \sum_i (C_i \theta_i U_{ai} / C\theta) \left(\sum_a U_a N_a / \sum_a U_{ai} N_a\right)$$

Table 8.3 Estimated elasticities by expenditure item

	Initial (A)	Food and beverages	Housing	Fuel and light	Clothing	Miscellaneous	Average (B)	Difference (A-B)
$\ln k_i$		3.14894 (0.609)	-4.11249 (1.194)	2.29658 (1.009)	-6.66175 (2.038)	-9.15330 (1.429)		
ϵ_i		0.69667 (0.046)	1.20709 (0.090)	0.62154 (0.076)	1.33037 (0.153)	1.53757 (0.107)		
θ_i	0.71092	0.65455 (0.030)	0.48899 (0.050)	0.53034 (0.050)	0.56211 (0.100)	1.09869 (0.070)	0.71092	0.00000
R^2		0.68756	0.43585	0.35990	0.24653	0.57341		

Note: Number in parenthesis are standard errors. Sample size = 293

29 Ages 14 and above are assumed to be adult-equivalent in terms of consumption expenditure. Although ages 25 and below would certainly require relatively more educational expenditure, the sample was not large enough to have more detailed age categories.

30 Using the final estimates in Table VII.3., k is estimated by the following equation.

$$k = 1/S \sum_{s=1}^{S} C_s / N_s^{\theta} \; : \text{ where } S = \text{total sample size and } s = \text{s-th sample}$$

$$= 509571$$

But the results of this procedure shown in Table VII.4. raise some questions. Frist, the standardized units for age 3 to 5 exceed the unity for all except the miscellaneous item. Second, in the case of housing expenditure, the units all exceed the unity, in the order of age 3-5 at 2.52, age 0-2 at 1.45, and age 6-13 at 1.07. The result seems to reflect the life cycle of the household heads and if this is true, the age of the household head should be controlled in the estimation. Third, there is a trade-off between convergence and R^2's for certain expenditure items. Convergence seems to have been achieved at the cost of lower R^2's for the fuel and light and the miscellaneous items.

For the above reasons, the initial estimates of the standardized adult equivalency units (the upper part in Table VII.4.) were utilized in time-series analysis.[31]

b. Estimation of the private consumption expenditure function

The size of private consumption expenditure (CON_p) is estimated by an equation which specifies *per capita* consumption as the function of *per capita* income and the past level of its own, all in terms of adult equivalent units.

$$\left(\frac{CON_p}{X}\right) = \underset{(0.0086)}{0.011725} + \underset{(0.0605)}{0.156724}\left(\frac{GNP}{X}\right) + \underset{(0.1180)}{0.779824}\left(\frac{CON_p}{X}\right)_{-1}$$

$$R^2 = 0.998, \quad n = 19\,(1961\text{-}79), \quad \text{D-W} = 1.6$$

$$X = NFM\,\left(\sum_a U_a \cdot FMS_a\right)^{\theta}$$

$$U_{0\text{-}2} = 0.64286, \quad U_{3\text{-}5} = 0.65578, \quad U_{6\text{-}13} = 0.68456$$

$$U_{14+} = 1 \qquad \theta = 0.71092$$

Table VII.4. Estimated adult equivalency units by expenditure item

Commodity group	Age-group				R^2
	0 – 2	3 – 5	6 – 13	14+	
Initial value (A)	0.65455(0.64286)	0.66771(0.65578)	0.69701(0.68456)	1.01819 (1)	0.41585
Food and beverages	0.76339(0.72401)	0.93084(0.88282)	0.88378(0.83819)	1.05439 (1)	0.57822
Housing	1.61894(1.07833)	1.45709(0.97053)	0.94336(0.62835)	1.50134 (1)	0.10814
Fuel and light	1.00721(0.82748)	0.65829(0.54082)	0.74188(0.60950)	1.21720 (1)	0.14483
Clothing	0.76454(0.39642)	1.39593(0.72381)	1.23973(0.64282)	1.92859 (1)	0.11437
Miscellaneous	0.44722(0.42590)	0.24554(0.23384)	0.57109(0.54387)	1.05005 (1)	0.51583
Average (B)	0.64397(0.63698)	0.62993(0.62309)	0.68060(0.67321)	1.01097 (1)	-
Difference (A-B)	-0.01058(-0.00588)	-0.03778(-0.03269)	-0.01642(-0.01135)	-0.00723 (0)	-
Initial value (A)	4.18029(0.78176)	7.38836(1.38171)	4.94468(0.92471)	5.34727 (1)	-
Food and beverages	3.07002(0.83266)	5.48968(1.48892)	3.84091(1.04174)	3.68701 (1)	0.59238
Housing	40.01329(1.44841)	69.45222(2.51404)	29.54793(1.06958)	27.62576 (1)	0.13620
Fuel and light	4.64412(0.95355)	5.21171(1.07009)	3.85792(0.79213)	4.87034 (1)	0.14044
Clothing	18.31003(0.58921)	66.97623(2.15526)	33.78572(1.08721)	31.07573 (1)	0.13802
Miscellaneous	2.95897(0.53835)	4.40119(0.80075)	4.10653(0.74714)	5.49635 (1)	0.48447
Average (B)	4.12301(0.78175)	7.28732(1.38172)	4.87696(0.92470)	5.27411 (1)	-
Difference (A-B)	-0.05729(-0.00001)	-0.10103(0.00001)	-0.06772(-0.00001)	-0.07316 (0)	-

Note: Numbers in parenthesis are standardized adult equivalant units. Sample size = 1,750

[31] Since the above estimates are based on urban households, application of the results to the time series of the national aggregate will result in bias if urban-rural differentials in terms of household expenditure patterns are important.

(b) Government consumption expenditure (CON_g)

Government consumption expenditure is assumed to be proportional to private consumption:

$$CON_g = \underset{(0.0016)}{0.152532}\ CON_p$$

$R^2 = 0.987$, n = 19 (1961-1979), D-W = 1.16

(c) Gross capital formation (GCF)

The rate of gross capital formation to GNP may be estimated as a function of *per capita* income (Suits-Mason, 1978). Figure 8.6 shows a rough relationship between the two variables using world cross-section data of four different years. A positive relation seems to exist up to a thousand dollar level of *per capita* income but from there on, no clear relation seems to hold between the two variables.

Based on the above observation and the fact that the Korean economy is very much a planned economy, the investment rate (GCFR) is treated as an exogenously given policy variable. Thus,

$$GCF_t = GCFR_t \cdot GNP_t$$

(d) Balance of payments (BOP)

The ratio of the balance between total exports and total imports to GNP (BOPR) is given exogenously, so that

$$BOP_t = XPT_t - MPT_t - BORP_t \cdot GNP_t$$

(e) Determination of GNP and its expenditure components

From the equations on private and government consumption, investment and the balance of payments, the size of GNP and its expenditure components are determined simultaneously by solving the following reduced equation and substituting its value into the equations for each component.

$$GNP_t = \frac{k}{1-GCFR_t-BOPR_t-\alpha(\beta+1)}$$

$$\text{where}\quad k = \frac{\left\{0.011725 + 0.779824\ \left(\frac{CON_p}{X}\right)_{t-1}\right\}}{X_t \cdot (\beta+1)}$$

$$\alpha = 0.156724$$

$$\beta = 0.152532$$

(f) Import (MPT) and export (XPT)

Traditional theory of international trade says that the size of trade for a country depends in the long-run, on her resource endowment. But with the resource endowment given, the size of trade in the short run depends on the size of population and the level of income (Chenery-Taylor, 1968). Using the *per capita* land size as a proxy for the endowment of natural resources, *per capita* commodity imports (MPT_c) is specified as a function of *per capita* income, *per capita* land size and the size of population. Cross-section data of 16 countries for four different time points[32] were used to estimate the equation which is specified in double-logs. With these imports estimated, total imports (MPT) are estimated as a linear function of commodity imports.

$$\ln\frac{MPT_c}{POP} = \underset{(0.468)}{1.30475} + \underset{(0.057)}{0.941146}\ \ln\frac{GNP}{POP}$$

$$- \underset{(0.0374)}{0.374635}\ \ln POP$$

$$- \underset{(0.0315)}{0.158624}\ \ln\frac{LND}{POP}$$

$$+ \underset{(0.0872)}{0.37202}\ (1-D)$$

$R^2 = 0.897$, n = 64

D = 1965 year dummy

$$MPT = -\underset{(333)}{122.1} + \underset{(0.0107)}{1.25032}\ MPT_c$$

$R^2 = 0.999$, n = 19 (1961-1979)

Exports are determined as a residual as follows:

$$XPT = MPT + BOP$$

2. The composition of GNP by industrial sector

Instead of estimating production functions by industry, a matrix was derived to convert the expenditure-sector components of GNP into the industrial components. The values added by industry are then obtained through the conversion matrix.

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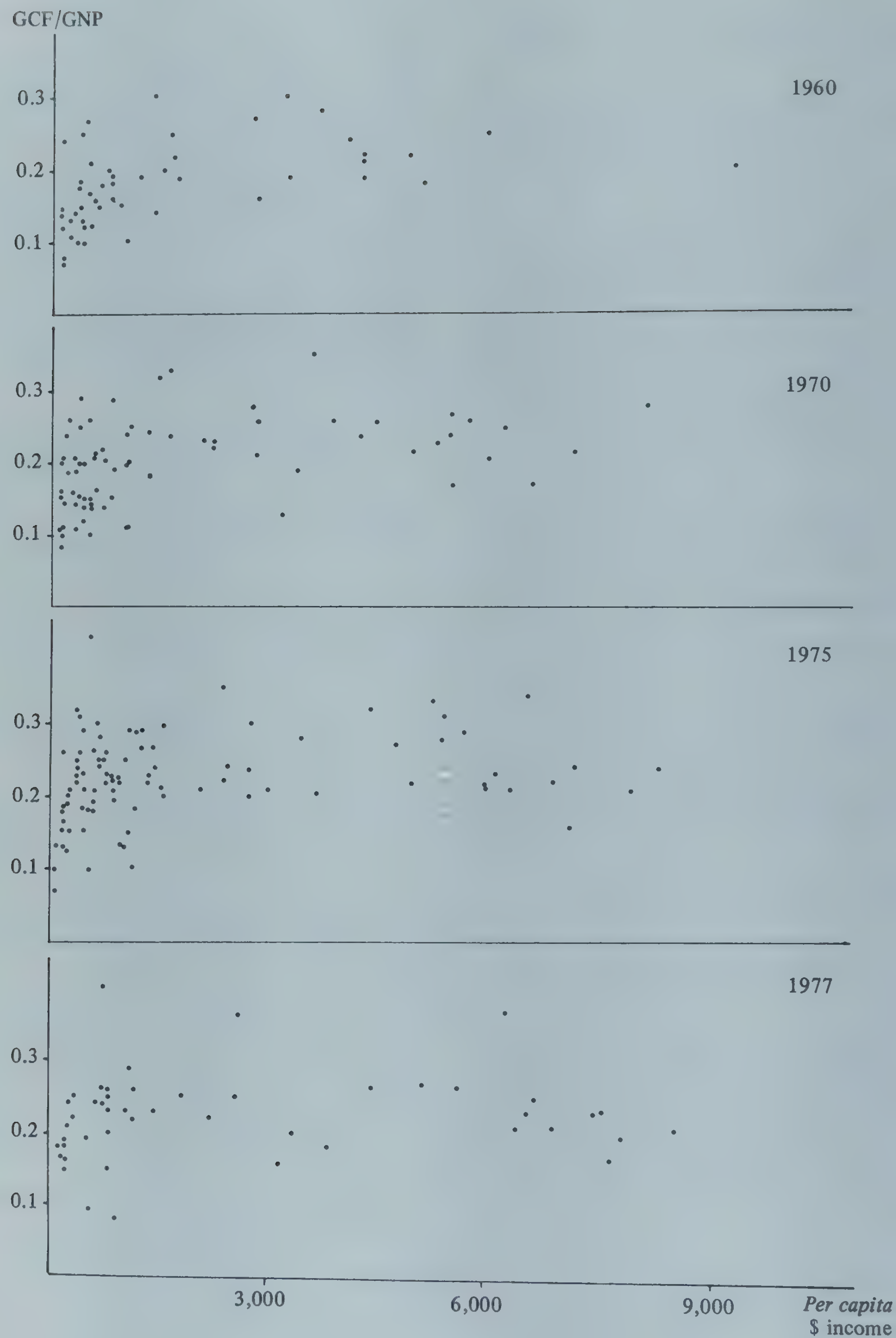
32 The countries are: Greece, Ireland, Spain, Italy, Japan, Austria, Finland, Netherland, France, Belgium, Germany, Norway, Canada, Denmark, Sweden and Republic of Korea. The years of 1965, 1973, 1975 and 1978 were covered for the countries.

Figure VII.5. *Per capita* income and the investment rate



Source: United Nations, *Statistical Yearbook*, 1978.

(a) The conversion matrix (C_{ij})

The elements of the matrix may be estimated from the national accounting data through regressing the industrial values added against the expenditure-sector components of GNP (Kresge, 1969). However, the method is not applicable to the Korean data which have very severe multi-collinearity. Thus, it is necessary to use Input-Output (I-0) Tables which provide industry-specific information. But since I-0 tables are not available annually and therefore provide only limited sample points, interpolation of the data is inevitable to extend the sample points.

Estimates of the elements in this direction are available from 1970 to 1979.[33] Based on these estimates, the trend line of each element is approximated by the following non-linear equations. Non-linearity is assumed so that the fitted value of each element stay between 0 and 1. $\ln \hat{C}_{ij} = b_0 + b_1 T$: for elements with declining trends, $\ln (1-\hat{C}_{ij}) = C_0 + C_1 T$: for elements with increasing trends.

One advantage of this method is that the column sums of the projected elements stay within very narrow ranges. Thus, it reduces the possibility of distorting the row structure of the matrix which tends to arise when each column sum is normalized to 1 (BOX 1975, pp. 44-51).

The estimated results of the C_{ij} – equations are listed in Table VII.5. Excepting the equations for C_{51}, C_{43} and C_{25}, the estimated slope coefficients are highly significant.

The initial estimates of the C_{ij} from the above equations, are normalized so that their column sums are 1.

$$C_{ij} = \hat{C}_{ij} / \Sigma_i \hat{C}_{ij}$$

(b) Value added by industry (VAD_i)

Given the conversion matrix (C_{ij}) and the expenditure vector ($GNPX_j$), the value added vector (VAD_i) is obtained by multiplication.

$$[VAD_i] = [C_{ij}] \cdot [GNPX_j]$$

Compared with the KDI projections (KDI, 1978), projections based on the above estimates showed only marginal difference within the range of 0.4 – 2 per cent in terms of the industrial composition of GNP.[34]

(c) Employment and the productivity of labour

(a) Expected labour productivity ($\hat{APL}_i$) and labour demand (LFD_i) by industry

It is assumed that the industrial demand for labour is a function of expected labour productivity. Then, using the trend in labour productivity as the proxy for the expected productivity, industrial demand for labour is estimated as in the following way. Industrial categories are broader in what follows, viz., primary, secondary and tertiary.

$$\underset{}{\hat{APL}_1} = \underset{(0.131)}{-0.176065} + \underset{(0.0003)}{0.0054083}\,(T\text{-}1900) + \underset{(0.253)}{0.511565}\;\hat{APL}_{1,t-1}$$

$$R^2 = 0.8639, \quad n = 16\ (1963\text{–}1978)$$

$$\hat{APL}_2 = \underset{(0.65)}{-1.339} + \underset{(0.011)}{0.023853}\,(T\text{-}1900) + \underset{(0.189)}{0.673587}\;\hat{APL}_{2,t-1}$$

$$R^2 = 0.979, \quad n = 16$$

$$\hat{APL}_3 = \underset{(0.518)}{-2.20595} + \underset{(0.0101)}{0.044088}\,(T\text{-}1900) + \underset{(0.226)}{0.052478}\;\hat{APL}_{3,t-1}$$

$$R^2 = 0.982, \quad n = 16$$

$$LFD_i = VAD_i / \hat{APL}_i$$

(b) Employment (EMP_i) and the actual productivity (APL_i) of labour by industry

Total employment is determined by supply and demand condition in the labour market. In the case of excess demand, there will be only structural unemployment which arises due to the lack of information, job search etc. Structural unemployment is assumed to be 3 per cent of total labour supplied. In the case of excess supply, some firms may employ more than they have originally planned in order to anticipate

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33 Research notes of Sung-Hwi Lee at KDI. A year-by-year iterative method was adopted for the years which do not have I-0 tables.

34 Using the same expenditure vector projected by KDI, the industrial composition of GNP in 1991 is projected to be 0.097 (agriculture), 0.424 (manufacturing), 0.193 (SOC) and 0.286 (other services), compared the KDI projection of 0.081, 0.444, 0.176 and 0.290.

Table VII.5. Estimation of C_{ij} trend-equations

		(1) Private consumption	(2) Government consumption	(3) Investment	(4) Export	(5) Import
(1) Agriculture	Intercept	2.11101**	1.64906**	3.93486**	3.23015**	4.05008**
	Slope	–.0425047**	–.0616153**	–.0853322**	–.655831**	–.0750925**
	R^2	.9631	.9507	.9778	.9752	.9819
(2) Light manufacturing	Intercept	(.170781)**	(–.00152361)	–2.32849**	(–.0615562)	–2.55048**
	Slope	(–.004002)**	(–.000676491)**	–.0104966*	(–.00226267)*	–.00025617
	R^2	(.9023)	(.6577)	.4469	(.4045)	.0087
(3) Mining & heavy manufacturing	Intercept	(.842698)**	(1.09768)**	(1.98773)**	(1.48632)**	(2.73676)**
	Slope	(–.0132668)**	(–.0176942)**	(–.0333201)**	(–.0240417)**	(–.0443823)**
	R^2	(.9728)	(.9727)	(.9807)	(.9772)	(.9832)
(4) Social overhead capital	Intercept	(.127271)**	(.112416)**	(–.204819)**	(.0488127)*	(–.0037736)
	Slope	(–.0025054)**	(–.00308958)**	(–.000720435)	(–.00170869)**	(–.00055575)*
	R^2	(.9437)	(.9000)	(.0547)	(.7879)	(.4463)
(5) Other services	Intercept	.758029**	1.22085**	2.11739**	.710397**	1.28428**
	Slope	–.00445178	–.0235631**	–.0472794**	–.027530**	–.0370393**
	R^2	.1828	.9672	.9764	.9225	.9230

( ): increasing trend, *: 5 per cent significance level, **: 1 per cent significance level

their future demand. In addition, structural unemployment will be lower because there are more applicants to a given job. However, the public works programme of the government seems to play a most important role in providing jobs at times of excess supply. In 1977 and 1978, the government expenditure on public works programmes stayed at 8.2 billion won in each year but it was increased to 20.9 billion won in 1980 when economic conditions deteriorated. Assuming that about half[35] of the excess supply is thus absorbed, total employment is determined as in the following.

$$EMP = \begin{cases} 0.97 \cdot LFS & \text{if } LFD \geqslant LFS \\ 0.5 \cdot (LFS - LFD) + 0.97 \cdot LFD & \text{if } LFD < LFS \end{cases}$$

Given the size of total employment, actual productivity of labour is obtained for each industry by adjusting expected productivity by the common ratio of employment to labour demand. Employment by industry is determined simultaneously and average productivity of labour for all industries is given as a weighted average of industrial labour productivities.

$$APL_i = \tilde{APL}_i \cdot (EMP/LFD)$$

$$EMP_i = VAD_i/APL_i$$

$$APL = \sum_i APL_i \cdot (EMP_i/EMP)$$

(c) Employment (EMP_g) and labour productivity (APL_g) by region

As Table VII.6. indicates, there is a very close linear relationship between the unemployment rates of the farm and the non-farm households. Using farm households for the rural and the others for the urban population,[36] regional employment rates are obtained from a linear relationship and the employment rate obtained above for the total labour force supplied.

35 No empirical study is available on this.

36 Census data shows very negligible differences in terms of employment rates due to this approximation.

Table VII.6. Unemployment rate by region

Unit: %

Year	Whole country	Farm	Non-farm Actual	Non-farm Fitted*
1967	6.2	2.3	11.1	10.6
1968	5.1	1.9	9.0	9.1
1969	4.8	2.2	7.8	10.2
1970	4.5	1.6	7.4	7.9
1971	4.5	1.5	7.4	7.5
1972	4.5	1.3	7.5	6.8
1973	4.0	1.0	6.8	5.6
1974	4.1	1.2	6.8	6.4
1975	4.1	1.3	6.6	6.8
1976	3.9	1.0	6.3	5.6
1977	3.8	1.1	5.8	6.0
1978	3.2	0.9	4.7	5.2
1979	3.8	0.9	5.6	5.2

Source: BOS, *Annual Report on Economically Active Population Survey*, 1979, pp. 32-33, 38-39 and 44-45.

* Fitted from the following equation:
Non-farm = 0.0171 + 3.875 Farm, $R^2 = 0.764$

Table VII.7. Employment by industry and region

Unit: 1,000 person

		Primary	Secondary	Tertiary	Unknown	Total
1966	Total	4 553	1 049	2 360	1	7 963
	Urban	258	623	1 482	1	2 364
	Rural	4 295	426	878	-	5 599
	Urban/Total	0.057	0.594	0.628		0.297
1970	Total	5 157	1 547	3 421	28	10 153
	Urban	278	1 053	2 394	17	3 742
	Rural	4 879	494	1 027	11	6 411
	Urban/Total	0.054	0.681	0.700		0.369
1975	Total	6 209	2 304	4 169	-	12 682
	Urban	368	1 759	3 022	-	5 149
	Rural	5 841	545	1 147	-	7 533
	Urban/Total	0.059	0.763	0.725		0.406

Source: Population censuses.

$$UMPR_r = [UMPR\text{-}0.0171\ (LFS_u/LFS)]\ /\ [3.875\ \ (LFS_u/LFS)+(LFS_r/LFS)]$$

$$UMPR_u = 0.0171 + 3.875\ UMPR_r$$

$$EMP_r = LFS_r(1\text{-}UMPR_r)$$

$$EMP_u = LFS_u(1\text{-}UMPR_u)$$

Industrial employment (EMP_i) obtained above is decomposed further by region based on two assumptions: (i) that 94 per cent of employment in primary industry is rural and, (ii) that employment in rural manufacturing industry constitutes roughly 10 per cent of the employment in rural primary industry. This allocation is based on recent data which is shown in Table VII.7. Employment in the rural tertiary industry and urban employment for each industry are all derived as residuals. Finally, regional productivities of labour are obtained through the average weighted by the industrial composition of regional employment.

$$EMP_{r,1} = 0.94\ \ EMP_1$$

$$EMP_{r,2} = 0.1\ \ EMP_{r,1}$$

$$EMP_{r,3} = EMP_r - EMP_{r,1} - EMP_{r,2}$$

$$EMP_{u,i} = EMP_i - EMP_{r,i}$$

$$APL_g = \sum_i APL_i\ (EMP_{g,i}/EMP_g)$$

Chapter VIII

POLICY ANALYSIS AND CONCLUSIONS

A. LIMITATIONS OF THE MODEL

The objective of this study was to describe demographic-economic interaction as fully as possible and to make it possible to analyse the longer term implications of both demographic and economic policies. However, the current model has limited interaction between the demographic economic sectors. The demographic sector in the model influences the economic sector only through the consumption function, by which only the size but not the composition of the GNP is affected. The level of *per capita* income is little affected if the size of family in terms of adult equivalent units does not vary greatly among different policy scenarios. On the other hand, the economic sector does not influence the total fertility rate, the trend of which is given exogenously. Until the crucial linkage is reasonably well established between the economic sector and the fertility variable, policy analysis through the current model will inevitably be very limited.

Thus, the policy analysis of the model is limited to seeing the effect of various population policies on the size and composition of population and the labour force. It differs from the conventional population projection models in that it allows for non-demographic conditions explicitly and has partial if limited linkages with them.

The exogenously determined variables in the demographic sector are selected for policy analysis: total fertility rate (TFR_g), emigration rate (emi), and net internal migration rate ($k.m_{a,s}$). By assigning different scenario to each of these variables, their implications are derived on the size and composition of the future population.

A 'basic prospect' is derived first as a reference point for comparisons. Then the results from different scenarios of the policy variables are compared with the basic prospect. All the indicators appearing in the model may be comparable but only those indicators which show significant differences are discussed in the text. However, some major indicators are listed in the appendix for those who are interested.

B. THE BASIC PROSPECT

Except for the case of the investment and emigration rates, the basic trends for the policy variables are specified in the model as functions of time (TFR_g, BOPR) or labour productivity ($k.m._{a,s}$). Since the past trend of these variables contain impacts of the past policies, extrapolation of the trend would implicitly assume that the future policies are pursued consistently over time.[37] Emigration rates are assumed to be 0.11 per cent of the population, based on the recent trends and the rates planned in the fifth development plan. Investment rates (GCFR) are assumed to stay around 0.316 through out the projection period and the foreign exchange gap (BOP) is assumed to disappear by the end of the projection period.[38]

According to the projection (Table VIII.1) based on the above assumptions,[39] the total fertility rate declines monotonically from 2.7 in 1981 to 2.3 in 1990 to 2.1 in 2000 and approaches almost to 2.0 in 2010. The population growth rate stays around 1.5 per cent until 1990 but declines continuously from then on to 1.0 per cent in 2000 and becomes 0.74 per cent by the year of 2010. As the result, the increment in population size during the immediate 15 years (1981-1995) exceeds that during the more distant 15 years (1995-2010), by 1.8 million.

The migration rate fluctuates around 0.7 per cent of total population until 2000 but declines there on to 0.5 per cent in 2010. However, the urbanization rate rises continuously and reaches 82 per cent in 2010.

Due mainly to the decline in fertility, the dependency ratio declines substantially during the 1980s; from 59.4 per cent in 1981 to 50.7 per cent in 1990. The declining trend is continuous up to 2010 when it reaches 43.5.

The size of the economically-active population increases monotonically but the labour force participation rate declines substantially from 1990 and as also does the size of rural economically-active population. The unemployment rate stays at a level higher than 5 per cent until 1990 but from 1994, it stays at the minimal 3 per cent level.

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37 The target TFR's in the fifth development plan are 2.6, 2.5, 2.4, 2.3 and 2.3 for the 1982-1986 period, compared to 2.63, 2.57, 2.52, 2.47 and 2.43 projected here. The plan projects urbanization at the level of 0.601, 0.615, 0.627, 0.640 and 0.651 which is higher than 0.584, 0.600, 0.610, 0.619 and 0.629 projected here. One reason for this rather severe difference in the projected urbanization rate is that the plan does not consider policy impacts.

38 Based on the fifth development plan and other projections;

GCFR = 0.312 in 1981 and 0.316 from 1982
BOPR = -0.3915 + 0.003559 (T-1900).

39 See the Appendix table 6 to 13 for more detailed results.

Table VIII.1. Basic prospect of major indicators

		1981	1985	1990	1995	2000	2005	2010
Population	1000 persons	38 706	41 188	44 451	47 528	50 236	52 472	54 495
Population growth rate	1/1000	15.2	15.8	14.6	13.7	10.0	8.1	7.4
Emigration rate	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total fertility	Rate	2.699	2.471	2.290	2.181	2.111	2.067	2.041
Urbanization	Rate	0.587	0.618	0.664	0.704	0.746	0.784	0.819
Net migration	Rate	0.012	0.007	0.007	0.007	0.007	0.006	0.005
Dependency	Ratio	0.594	0.542	0.507	0.500	0.482	0.457	0.435
Labour force participation	Rate	0.571	0.588	0.589	0.585	0.572	0.562	0.553
Labour force participation	1000 persons	14 779	7 791	18 558	19 942	21 126	22 323	23 319
(Rural)	1000 persons	6 875	7 550	7 570	7 236	6 563	5 952	5 363
Unemployment	Rate	0.052	0.057	0.057	0.030	0.030	0.030	0.030

C. FAMILY PLANNING PROGRAMME

Number of births averted through the family planning practice can be estimated as a function of the size of fecund age female population who use contraceptive methods, the efficiency of the method adopted and their potential fertility without use of any effective method.

$$B^t = \sum_i \sum_a p^{t-1}_{i,a} \cdot E_i \cdot \alpha$$

Where B^t = births averted in the year t, $p^{t-1}_{i,a}$ = number of fecund age women who use i-th method at age a in t-1 year, E_i = efficiency of the method[40] and α = potential fertility.[41]

Out of total births averted, the births averted by the government-supported users can be attributed to the government family planning programme. Dividing the births averted by the fecund age female population, the fertility reduction due to the government programme is estimated as:

$$\triangle F = B^t \cdot g^{t-1} / \sum_a P_a$$

where $\triangle$ F is the reduction in total fertility rate due to the government family planning programme (FP:); $g^t - 1$ is the share of the government-supported over total users, and P_a is the fecund age female population.

[40] It is assumed that each method has the following efficiency: sterilization - 1, IUD = 0.9, pill = 0.7, condom and other method = 0.6.

[41] Potential fertility assumed to be 0.328 (SUN, 1975).

However, the estimated $\triangle$ F is not all attributable to the government programme. This is because even without the programme, some of those who were supported in the past would continue to practice family planning on a voluntary basis. Therefore, the cancellation of the government programme this year would not lead to an increase of $\triangle$ F in total fertility rate next year than would otherwise have been the case.

With this in mind, an average of $\triangle$ F's for the 1970s was used rather than a single estimate for one most recent year. The estimate obtained was 1.44,[42] which seems reasonable considering the increasing trend of $\triangle$ F's through the broader coverage of the government programmes.

The question now is 'what happens if there is no government programme?' Obviously, fertility would not be always higher by 1.44 than it would be otherwise. Through time more of those users who were supported by the government would become voluntary users, though it may take considerable length of time for all of them to become voluntary users. Thus, the impact of an abrupt discontinuation of the government programme depends on the length of time, as well as the rate, of the adjustment which is required for government-supported users to become voluntary users with the same efficiency in the methods adopted.

An extensive study may be required to identify the probable adjustment process. With no research

[42] Derived from KIFP Fertility-Abortion Surveys of 1971, 1973, 1976, and 1979 and MOHSA 1980. Estimates ranged from 1.0 in 1972 to 2.0 in 1980.

results readily available, a simplifying assumption is made about the adjustment rate; that the $\triangle$ F due to the government programme decreases uniformly over time once the programme ceases to exist. Then, given the adjustment period $\triangle t$, the remaining $\triangle$ F at time t becomes:

$$\triangle F_t = 1.44 \; [1 - (t-t_o)/\triangle t]$$

where t_o is the year from which there is no government programme and $t_0 \leqslant t \leqslant (t_0 + \triangle t)$.

In what follows, two different assumptions are made on the length of the adjustment period; (i) 5 years and (ii) 10 years.

1. Adjustment in 5 years (Assumption F-1)

The difference from the basic prospect is that the total fertility rate, both for the urban and the rural area, is higher during the adjustment period of 1982 to 1986. From 1987 on, there exists no difference in the regional fertility level by assumption.

Due to the higher fertility levels, population size (Table VIII.2.) differs by 1.3 million in 1985. Although the difference stays around 1.5 million up to the year of 2000, it increases further to 2.2 million by 2010 when the 1982-1986 birth cohort reaches the prime age of fecundity. While the total population increases only by about 30 per cent during the 1985-2010 period in the basic projection, the incremental population of 1.3 million due to the fertility assumption increases by almost 100 per cent. This indicates that the growth potential of population depends largely on the size of younger age population.

Compared to the basic projection, dependency ratio stays higher until the additional birth cohort reaches age 15. But once the cohort passes that age, the ratio becomes lower until the cohort reaches fecund age. The difference in dependency ratio thus alternates by the life cycle stage of the cohort and their descendants.

The higher fertility lowers the labour force participation rate (LFR) of the fecund age women, and thereby results in smaller number of economically active population (LFS) during the adjustment period. The difference in LFR from the basic projection, depends on the difference in age composition due to the fertility assumption. The size of LFS, however, is always bigger than that of the basic projection after 2000. Thanks to the reduced size of LFS, the unemployment rate is lower than that of the basic projection until 1990. But there is little difference after that.

2. Adjustment in 10 years (Assumption F-2)

If the adjustment takes 10 years instead of 5 years, there will be 3.3 million more population in 1990 and 4.9 million more in 2010 than that from the basic projection (Table VIII.3.). Compared to the previous assumption (F-1), the size of population is larger by 1.8 million in 1990 and 2.6 million in 2010.

Table VIII.2. Differences due to the change in fertility rates (F-1)

		1985	1990	1995	2000[1]	2005	2010
Population	1000 persons	1 299	1 556	1 544	1 541	1 673	2 248
Population growth rate	1/1000	5.9	-0.6	-0.4	-0.2	0.7	2.1
Total fertility	Rate	0.627	0.000	0.000	0.000	0.000	0.000
Urbanization	Rate	0.009	0.002	0.004	0.002	-0.001	-0.001
Net migration	Rate	-0.001	0.000	0.001	-0.001	-0.001	0.000
Dependency	Ratio	0.048	0.053	0.049	-0.009	-0.015	0.002
Labour force participation	Rate	-0.022	0.000	0.000	-0.008	0.001	0.003
Labour force participation	1000 persons	-611	-8	-3	496	910	983
(Rural)	1000 persons	-489	-11	-58	122	236	242
Unemployment	Rate	-0.027	-0.013	0.000	0.000	0.000	0.000

Table VIII.3. Differences due to the change in fertility rates (F-2)

		1985	1990	1995	2000	2005	2010
Population	1000 persons	1 582	3 324	3 896	3 874	4 023	4 887
Population growth rate	1/1000	9.5	5.2	-1.1	-0.7	0.6	3.4
Total fertility	Rate	1.167	0.716	-0.001	0.000	0.000	0.000
Urbanization	Rate	0.014	0.011	-0.010	0.006	0.001	-0.001
Net migration	Rate	0.000	0.000	0.001	-0.001	-0.001	0.000
Dependency	Ratio	0.059	0.112	0.124	0.045	-0.018	-0.014
Labour force participation	Rate	-0.040	-0.023	-0.001	-0.013	-0.007	0.004
Labour force participation	1000 persons	-1 141	-727	-31	601	1 647	2 298
(Rural)	1000 persons	-871	-562	-183	61	384	532
Unemployment	Rate	-0.027	-0.027	0.000	0.000	0.000	0.000

The dependency ratio is higher than that of the basic projection but becomes lower after 2000. The labour force participation rate shows an opposite pattern. The size of the economically-active population is smaller than that of the basic projection during the adjustment period but becomes larger after that period. As the result, unemployment rate is lower during the adjustment period.

D. EMIGRATION

Emigration has various policy implications. Besides relieving the domestic population pressure, it may become a considerable source of foreign exchange and/or a basis of international co-operation. As for population policy, its impact on the size of population depends not only on the number but also on the composition of the emigrants. Problems associated with the brain drain, which developing countries often experience by the selective immigration policies of the recipient countries, cannot be ignored.

But since all these aspects cannot be analysed properly by the current model, the analysis is limited to the effect of emigration on the size of domestic population. Two assumptions were made for this: (i) that there is no emigration from 1982, and (ii) that the emigration rate is 0.11 until 1991 as it is assumed in the basic projection but it is 0 after that year.

1. No emigration from 1982 (Assumption E-1)

When there is emigration, population size at a point in time will differ by the amount which the total emigrants up to that point in time might have naturally increased had they not emigrated. If the ratio between the hypothetically reduced size of domestic population and the total number of emigrants is denoted as the 'emigration multiplier', the multiplier becomes 1 when the net reproduction rate of the domestic population is 1 and the population has the composition of a stationary population. Given the composition, the multiplier becomes larger as the fertility is higher and the mortality is lower. That is, it becomes larger as the rate of natural increase of the population in question is higher. According to the basic projection, the natural increase rate of the Korean population decreases monotonically from 1985 so that the multiplier gets smaller as the timing of emigration is delayed from the present.

In the basic projection, two assumption were made on emigration. The first is that the annual emigration rate is fixed at 0.11 per cent over the whole projection period. The second is that the composition of the emigrants is identical to that of the non-emigrants in terms of age, sex, and region. Under these assumptions, the effect of emigration on population size up to the T-th year ($\triangle P_T$) equals the number of migrants at the T-th year multiplied by the length of the period (T). That is,

$$\triangle P_T = \alpha \cdot T \cdot P_o \prod_{t-1}^{T} (1+RNI_{t-1})\ (1-\epsilon) \quad \text{because}$$

$$P_T = P_o \prod_{t=1}^{T} (1+RNI_t)\ (1-\epsilon)$$

where P = non-emigrants, ϵ = emigration rate,

$\alpha = \epsilon/(1-\epsilon)$.

Due to the rigid assumptions adopted, the effect of emigration on the size of domestic population is likely to be underestimated. This arises because emigrants tend to have a younger age composition and so have a potentially higher natural increase rate than non-emigrants. Thus, the analysis here suggests only a minimal effect of emigration on the size of domestic population.

Table VIII.4. shows some distinctive differences between the basic projection and the assumption E-1. According to the assumption E-1, the size of population is larger by 0.4 million in 1990, 1.0 million by 2000 and 1.7 million in 2010. But since it is assumed that the composition of emigrants is identical to that of non-emigrants, there is no difference in the dependency ratio, the labour force participation rate and the total fertility rate. But the size of the economically-active population is larger proportionally to the size of additional population. Therefore, the unemployment rate is higher initially.

2. No emigration from 1992 (Assumption E-2)

This assumption differs from the basic projection for the projection period after 1992 but it differs from the assumption E-1 for only the period of 1982-1991. As mentioned above, the simplifying assumptions on the rate and composition of emigration makes it easy to calculate the differential in population size due to the alternative assumptions. Thus, it may be more desirable to change the assumptions concerning the composition or the rate of emigration. But in view of the uncertain immigration policy of the recipient countries, the assumptions adopted may produce a realistic profile.

As is shown by Table VIII.5., population size according to the assumption is larger than that of the basic projection by 0.5 million in 2000, 1.1 million in 2010. Compared to assumption E-1, the size is less by 0.6 million in 2010, about 1.3 times as much as the size of total emigrants during the 1982-1991 period. Compared to the result of Table VIII.4., the difference from the basic projection is reduced substantially for other indicators also, but the patterns are very similar.

E. POPULATION REDISTRIBUTION

In the basic projection, urbanization is treated endogenously as a function of labour productivity. The composition of net internal migrants is determined thereby according to the given relative migration propensities by age and sex. However, the regression coefficient for labour productivity in the urbanization rate equation includes implicitly the effect of population redistribution policy in the past.[43] Ideally, the effect of population redistribution policy could be analysed by identifying its impact on the sensitivity of urbanization to the labour productivity. But with the current data availability, this is not feasible. Therefore, it is assumed that the observed migration rates during the period of 1965-1970 be the rates in the absence of population redistribution policy.[44] In what follows, two assumptions are made about the presence of the population redistribution policy;

[43] The urbanization trend would have been lowered by the extent to which the population policy had been effective. Therefore, the estimated coefficient for labour productivity in the equation would have been larger without the population redistribution policy.

[44] Since Korea experienced industrialization and urbanization very rapidly during the 1965-1970 period, migration rates of rural population would have decreased even under no redistribution policy in the 1970s. This is because as urbanization proceeds, more and more immobile elements would remain in the rural area. Thus, the policy impact is very likely to be overestimated by this assumption.

Table VIII.4. Differences due to the change in emigration rates (E-1)

		1985	1990	1995	2000	2005	2010
Population	1000 persons	177	430	719	1 035	1 370	1 722
Population growth rate	1/1000	1.0	1.1	0.0	1.1	1.0	1.0
Emigration	1/1000	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Labour force participation	1000 persons	77	191	318	458	608	764
(Rural)	1000 persons	35	79	118	145	164	178
Unemployment	Rate	0.001	0.000	0.000	0.000	0.000	0.000

Table VIII.5. Differences due to the change in emigration rates (E-2)

		1995	2000	2005	2010
Population	1000 persons	206	488	814	1 126
Population growth rate	1/1000	0.0	1.1	1.0	1.1
Emigration rate	1/1000	-1.1	-1.1	-1.1	-1.1
Labour force participation	1000 persons	88	217	356	503
(Rural)	1000 persons	34	68	96	117

(i) no redistribution policy from 1982 and (ii) no redistribution policy from 1992.

1. No redistribution policy from 1982 (Assumption M-1)

Compared to the basic projection, the net migration rate is higher by 0.4 percentage point in 1985 (Table VIII.6.) but the difference gradually decreases to 0.1 percentage point in 2000. As a result, the urbanization rate is higher by 4.3 in 1990, 4.8 in 2000 and 3.6 percentage point in 2010.

Due to the more rapid urbanization, the fertility rate of the country is lower up to the year of 2010 so that the size and the growth rate of population are slightly lower than those of the basic projection. The size of economically active population becomes smaller due largely to the lower labour force participation rate which results from the more rapid urbanization. As a result, the unemployment rate is lower than that of the basic projection but the labour shortage in rural areas becomes very serious.

2. No redistribution policy from 1992 (Assumption M-2)

Compared to the basic projection, the net migration rate is higher by 0.5 in 1992 and 0.1 percentage point in 1995 but the difference is negligible from 2000 (Table VIII.7.). The difference in the urbanization rate stays at 1.3 up to 2005 but reduces to 1.0 percentage point in 2010. In 2010, the urbanization rate differs from that of the assumption M-1 by 2.3 percentage points.

As with M-1 comparison with the basic projection shows a lower over-all fertility rate from 1990s, a smaller population size, a lower labour force participation rate and a substantial decrease in the size of the rural labour force.

F. CONCLUSIONS

1. Summary of the results

Based on the results of the policy analysis the following suggestions can be made.

(a) As Figure VIII.1. shows, the size of population in the future is affected greatly by the direction of the family planning programme and emigration policies. But it is rather insensitive to the direction of population redistribution policy since the urban-rural fertility difference is very small already[45] and will disappear during the earlier period of the projection. Although there may be some mortality differential between regions, it is more likely to cancel out the fertility effect on the size of population since the urban area has better medicare facilities and so has lower mortality.

(b) As far as there is time lag for the government-supported contraceptors to become fully voluntary contraceptors, the current family planning programme should not be relaxed. For the controlling of the size of population, fertility control is more effective than emigration. This is obvious from the result that even if the adjustment time lag is only five years, withdrawal of the government family planning programme results in a larger population size than that resulting from the absence of 0.11 per cent annual emigration for a considerable length of time.

(c) If the adjustment period is 10 years rather than 5 years, the incremental population is more than proportional to the length of the adjustment period. The reason is that there are relatively more fecund age female population during the 1987-1991 period compared to the 1982-1986 period.

[45] As of 1979, the rural TFR is estimated to be 3.0 while the urban TFR is 2.4.

Table VIII.6. Differences due to the change in migration rates (M-1)

		1985	1990	1995	2000	2005	2010
Population	1000 persons	-5	-25	-45	-60	-67	-75
Population growth rate	1/1000	-0.1	-0.1	-0.1	0.0	-0.1	0.0
Total fertility	Rate	-0.009	-0.011	-0.009	-0.005	-0.002	-0.001
Urbanization	Rate	0.028	0.043	0.051	0.048	0.043	0.036
Net migration	Rate	0.004	0.002	0.000	-0.001	-0.001	-0.001
Labour force participation	Rate	-0.004	-0.008	-0.009	-0.009	-0.009	-0.008
Labour force participation	1000 persons	-121	-242	-320	-355	-362	-367
(Rural)	1000 persons	-559	-987	-1 247	-1 246	-1 217	-1 152
Unemployment	Rate	-0.003	-0.006	0.000	0.000	0.000	0.000

Table VIII.7. Differences due to the change in migration rates (M-2)

		1995	2000	2005	2010
Population	1000 persons	-1	-4	-7	-9
Total fertility	Rate	-0.002	-0.002	-0.001	-0.001
Urbanization	Rate	0.012	0.013	0.013	0.010
Net migration	Rate	0.001	0.000	-0.001	-0.001
Labour force participation	Rate	-0.002	-0.002	-0.002	-0.002
Labour force participation	1000 persons	-59	-85	-92	-88
(Rural)	1000 persons	-269	-320	-326	-307

(d) Insofar as the age-sex composition of emigrants is not drastically different from that of non-emigrants, the current rate of emigration has a very limited effect on the size of domestic population. The difference in population size between the assumption E-1 (no emigration from 1982) and the assumption E-2 (no emigration from 1992), stays within such a limited range that the two curves in Figure VIII.1. move almost in parallel. Thus, emigration has a significant effect on the size of population only after it has been pursued over long period. However, it is quite obvious that earlier emigration is more preferable to later (if the timing is to be chosen) since fertility is on a decreasing trend.

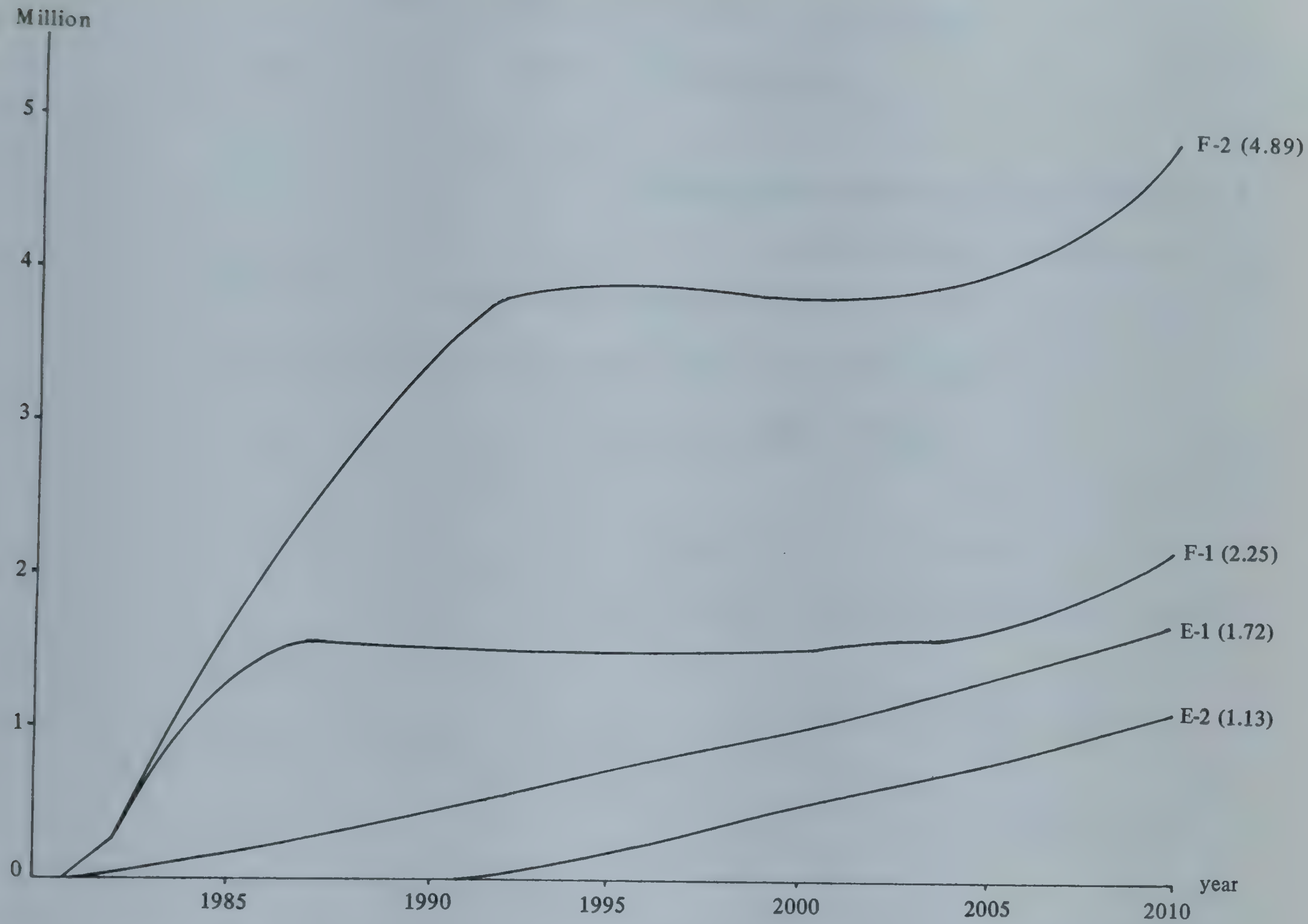
(e) The impact of rapid urbanization on the size of population is negligible since the urban-rural difference in the level of fertility becomes smaller. Thus, population redistribution policy should directly aim at solving the already severe regional unbalance, the manpower shortage in rural areas and the heavy concentration of population in the urban areas.

From the above, it is apparent that population policies become effective only if they are pursued steadily over the long run. Although negligible in the short run, the effect of persistent policy implementation is substantial when it is cumulated over the long-term. Thus, the implication is that current policies on fertility, emigration and internal migration should all continue to be pursued regardless of whether they were perceived to be successful in the past.

2. Suggestions for further research

Considering the limitation of the model in terms of policy analysis, the following suggestions can be made for improving the model.

Figure VIII.1. Differences in population size: comparisons with basic projection



First, the recent change in the fertility of the Korean population needs to be more rigorously analysed in terms of its determinants. Along with the frequently cited factors such as education, income and infant mortality, the impact of the family planning programme should be incorporated more explicitly. In order to do this, currently available cross-section data need to be pooled to obtain a more comprehensive picture through time. This is because the time series data are too short to provide any statistically significant estimates. Only after we have succeeded in providing convincing estimates, will the simulation results based thereon have persuasive power to the policy makers.

Secondly, it is necessary to set a capacity constraint from the production side of the economic model. The current model is solely demand driven with no capacity constraint. In this regard, a more extensive study of households' savings behaviour is required (and this is desirable whether or not production function approach is taken). Immediately applicable studies are currently non-existent in the Republic of Korea. Few studies deal properly with the impact of the demographic factors on the households' savings, often because of lack of reliable household income data in the Republic of Korea.

In addition, the current model could usefully further disaggregate the government and foreign sectors. Introducing the government sector is crucial for a model which aims to be a planning model. If a model cannot deal with reasonably well defined policy alternatives, its life will inevitably be short. For similar reasons, it is desirable to have a more expanded foreign sector which is central to the performance of the Korean economy.

APPENDIX I: ORDER OF COMPUTATION

A. DEMOGRAPHIC SECTOR

1. Life expectancies at birth and the survival of population

(a) The female life expectancy at birth (e_o^f)

$$\ln(77.5 - e_o^f) = 4.5886 - 0.34738X + 0.07435X^2D_2 - 0.25835X^3D_2$$
$$+ 0.040687\,[(X-0.5)^3 D_1 D_2 + (0.75X-0.125)(1-D_2)]$$
$$- 0.038738\,(T-1900)$$

$X = 0.5735 \cdot PCY\text{-}1$

$D_1 = 1$ if $-0.5 < X \leqslant O$, $\quad D_2 = 1$ if $X \leqslant O$

(b) Survival rates ($Q_{a,s}$) and the male life expectancy (e_o^m)

$$Q_{a,s} = Q_{a,s}^L + (Q_{a,s}^{L+1} - Q_{a,s}^L) \cdot \frac{e_o^f - e_o^{f,L}}{e_o^{f,L+1} - e_o^{f,L}}$$

$$e_o^m = e_o^{m,L} + (e_o^{m,L+1} - e_o^{m,L}) \; \frac{e_o^f - e_o^{f,L}}{e_o^{f,L+1} - e_o^{f,L}}$$

$e_o^L \leqslant e_o < e_o^{L+1}$ L is the corresponding life table level.

(c) Population age 1^+

$$POP_{a,s,g,t} = POP_{a-1,s,g,t-1} \cdot (Q_{a,s,t-1} \cdot Q_{a,s,t})^{0.1}$$

2. Fertility and the population age below 1

(a) Total fertility rate (TFR_g)

$$\ln(TFR_g - 2) = 6.86119 + 0.668153D_r - 0.0925494\,(T-1900)$$

(b) Mean age at child birth (ACB_g)

$$\ln(\hat{ACB}_g - 27) = 4.65019 + 0.523887D_r - 1.39057\,\ln PCY_{t-1} + 0.134464\,\ln EDU_{t-1}^{f,20\text{-}44}$$
$$-1.53694\,\ln ACB_{t-1}$$

(c) Age specific fertility rates ($AFR_{a,g}$)

(i) $20 \leqslant a < 40$

$$AFR_{a,g} = TFR_g \cdot f_{a.g}$$

$$f_{a,g} = (F_{a+1,g} - F_{a,g}) \cdot D + 0.2\,(F_{40,g} - F_{35,g}) \cdot (1-D)$$

$$D = 1 \quad \text{if } a < 35$$

$$F_{a,g} = [\,1 + \exp\left\{Z_g(\ln TFR_g - 3.5)\right\}\,]^{-1}$$

$$Z_g = -0.57841 + 4.5206X + 3.5155X_g^2 + 0.037605X_g^2 \cdot ACB_g + 131.66X_g^3$$

$$+ [-163.17X_g^3 + \left\{74.124(X_g - 0.15)^3 - 82.318(X_g - 0.3)^{3}D_3\right\} D_2\,]\,D_1$$

$$X_g = a/ACB_g - 0.85$$

$$D_1 = 1 \text{ if } X_g > 0, \quad D_2 = 1 \text{ if } X_g > 0.15, \quad D_3 = 1 \text{ if } X_g > 0.3$$

(ii) $a < 20$

$$AFR_{a,g} = 0.04 \cdot (2a-29) \cdot F_{20,g} TFR_g$$

(iii) $a \geqslant 40$

$$AFR_{a,g} = 0.2 \cdot (1-F_{40,g}) \cdot TFR_g$$

$$ACB_g = \sum_a a\,(AFR_{a,g}/TFR_g)$$

(d) Birth (BTH_g) and the population age below 1 ($\widehat{POP}_{o,s,g}$)

$$BTH_{g,t} = \sum_{a=15}^{44} AFR_{a,g,t} \cdot \widehat{POP}_{a,f,g,t}$$

$$BTH_g = 0.5\,(BTH_{g,t-1} + BTH_{g,t})$$

$$BTH_{m,g} = 0.512\ BTH_g\ , \quad BTH_{f,g} = 0.488\ BTH_g$$

$$\widehat{POP}_{o,s,g,t} = 0.5\,(BTH_{s,g,t-1} \cdot Q_{o,s,g,t-1}^{0.25} \cdot Q_{o,s,g,t}^{0.5} + BTH_t \cdot Q_{o,s,g,t}^{0.25})$$

3. Death (DTH_g) and the natural growth of population

$$DTH_g = POP_{g,t-1} + BTH_g - \hat{POP}_{g,t}$$

$$CBR_g = BTH_g/POP_{g,t-1} + \hat{POP}_{g,t})/2000$$

$$CDR_g = DTH_g/(POP_{g,t-1} + \hat{POP}_{g,t})/2000$$

$$RNI_g = CBR_g - CDR_g$$

$$NRR_g = \prod_{a=0}^{45} Q_{a,f} \cdot [\cdot D + AFR_{a,g}(1-D)]$$

$$D = 1 \quad \text{if} \quad a < 15$$

4. Migration ($MIG_{a,s}$) and the regional distribution of population

(a) Urbanization rate (URB)

$$\ln(1-URB_t) = 1.77085-0.505249 \ln APL_{t-1}$$

$$POP_{u,t} = POP_t \cdot URB_t$$

$$POP_{r,t} = POP_t \cdot (1-URB_t)$$

$$MIG_t = POP_{r,t-1} + BTH_r - DTH_r - POP_{r,t}$$

(b) Net internal migration ($MIG_{a,s}$)

(i) $a \geqslant 1$

$$\check{MIG}_{a,s} = m_{a,s} \cdot \check{POP}_{a,s,r}$$

(ii) $a < 1$

$$MBTH_{m,t} = 0.512 \ MBTH_t$$

$$MBTH_{f,t} = 0.488 \ MBTH_t$$

$$\hat{MIG}_{o,s} = (MBTH_{t-1} \cdot Q_{o,s,t-1}^{0.5} \cdot Q_{o,s,t}^{0.25} + MBTH_t \cdot Q_{o,s,t}^{0.25})/2$$

(iii) $k_t = MIG_t/\sum_a\sum_s \hat{MIG}_{a,s,t}$

$$MIG_{a,s,t} = k_t \cdot \hat{MIG}_{a,s,t}$$

(c) Number of emigrants (EMI) and the size and composition of regional population

$$EMI_{a,s,g} = POP_{a,s,g} \cdot emi$$

$$POP_{a,s,u} = (\hat{POP}_{a,s,u} + MIG_{a,s}) \ (1-emi)$$

$$POP_{a,s,r} = (\widehat{POP}_{a,s,r} - MIG_{a,s})\ (1\text{-}emi)$$

$$DPR_g = (POP_{14^-,g} + POP_{65^+,g}) / POP_{15\text{-}64,g}$$

$$SXR_g = POP_{m,g} / POP_{f,g}$$

5. **Average family size ($FMS_{a,g}$) and the number of families (NFM_g)**

$$\ln FMS_g = 2.37232\text{-}0.01111(T\text{-}1900)+0.9274\ D_r+0.000596\ TFR_g$$

$$NFM_g = POP_g / FMS_g$$

$$FMS_{a,g} = POP_{a,g} / NFM_g$$

B. MANPOWER SECTOR

1. **Education**

(a) Secondary school enrolment (enr)

$$\ln(1\text{-}enr) = -0.517014+0.672121\ \ln(POP_{13\text{-}18}/POP_{20+})\ -0.84053\ \ln PCY_{t-1}$$

(b) Proportion educated high school and above ($EDU_{a,s,g}$)

(i) a = 18

$$\ln(1\text{-}EDU) = 1.11217+0.0258019\ \ln \frac{POP_{18}}{POP_{20+}} - 0.0192901 \cdot \ln(T\text{-}1900)$$

$$\ln(1 - \frac{EDU_r}{EDU_u}) = 0.86828\text{-}0.021569\ (T\text{-}1900)$$

$$\ln(1 - \frac{EDU_{f,g}}{EDU_{m,g}}) = 3.94283\text{-}0.068231\ (T\text{-}1900)\text{-}0.54936\ D_u$$

$$EDU_{18,u} = \frac{EDU_{18}}{[\frac{POP_{18,u}}{POP_{18}} + (\frac{EDU_{18,r}}{EDU_{18,u}})(\frac{1 - POP_{18,u}}{POP_{18}})]}$$

$$EDU_{18,r} = \frac{EDU_{18}}{[\frac{1 - POP_{18,u}}{POP_{18}} + (\frac{EDU_{18,u}}{EDU_{18,r}})(\frac{POP_{18,u}}{POP_{18}})]}$$

$$EDU_{18,g,m} = \frac{EDU_{18,g}}{[\frac{POP_{18,g,m}}{POP_{18,g}} + (\frac{EDU_{18,g,f}}{EDU_{18,g,m}})(\frac{1 - POP_{18,g,m}}{POP_{18,g}})]}$$

$$EDU_{18,g,f} = \frac{EDU_{18,g}}{\left[\frac{1-POP_{18,g,m}}{POP_{18,g}} + \left(\frac{EDU_{18,g,m}}{EDU_{18,g,f}}\right)\left(\frac{POP_{18,g,m}}{POP_{18,g}}\right)\right]}$$

(ii) $a > 18$

$$EDU_{a,s,r,t} = EDU_{a-1,s,r,t-1}$$

$$EDU_{a,s,u,t} = EDU_{a-1,s,u,t-1} \cdot \frac{(POP_{a,s,u,t} - MIG_{a,s,t})}{POP_{a,s,u,t}}$$

$$+ EDU_{a,s,r,t} \cdot \frac{MIG_{a,s,t}}{POP_{a,s,u,t}}$$

2. Economically active population

(a) Labour force participation rate ($LFR_{a,s,g}$)

(i) The male

a. *Urban:*

$$\ln\left(\frac{LFR}{1-LFR}\right) = 0.289336 + 0.315758X_1 + 0.757779\,\dot{APL}\cdot X_1 - 0.011815X_2$$
$$-0.70297X_3 - 0.684345D_{60+}$$

$$X_1 = (a-a_0)D_1 + (a_1-a_0)\left[(D_2+D_3) - \frac{a-a_2}{a_3-a_2}D_3\right]$$

$$X_2 = (a-a_1)D_2 + (a_2-a_1)\left(1-\frac{a-a_2}{a_3-a_2}\right)D_3$$

$$X_3 \quad \frac{a-a_2}{a_3-a_2}D_3$$

$$D_1 = 1 \text{ if } a<a_1,\quad D_2 = 1 \text{ if } a_1 \leqslant a < a_2,\quad D_3 = 1 \text{ if } a \geqslant a_2$$

$$D_{60+} = 1 \text{ if } a > 60$$

b. *Rural:*

$$\ln\left(\frac{LFR}{1-LFR}\right) = -0.844238 + 0.414226X_1 + 0.549658\,\dot{APL}_1 \cdot X_1$$
$$+0.0161402X_2 + 1.61805X_3 - 1.54526D_{60+}$$

$$a_0 = 15,\quad a_1 = 25,\quad a_2 = 45,\quad a_3 = 70$$

(ii) The female

a. Age 20-44

Urban: $(1-LFR_a) = 0.6538 - 0.2376D_{20-24} + 0.1243D_{25-29}$
$+0.1022D_{30-34} + 0.0396D_{35-39} + (0.0256 + 0.19D_{20-24})\,TFR_a$

Rural: $(1-LFR_a) = 0.085+0.1149D_{25-29}+(0.0698+0.319D_{20-24}$

$+0.0663D_{25-29}+0.039D_{30-34}+0.0103D_{35-39})\ TFR_a$

$D_{20-24}\cdots$ = Age dummy

b. Other ages

Urban:

$$LFR^{45-60}_{a,f,u} = LFR^{40-44}_{u,f} + 0.006 - \frac{a-47.5}{17.5}(LFR^{40-44}_{u,f} - 0.087)$$

$$LFR^{60+}_{f,u} = 0.059$$

$$LFR^{15-19}_{f,u} = 0.555 - 1.4809\ TFR_a - 0.222\ EDU_{18-19,f,u}$$

$$LFR^{14}_{f,u} = 0.175$$

Rural:

$$\widetilde{LFR}^{45-60}_{a,f,r} = \widetilde{LFR}^{40-44}_{r,t} - 0.004 - 0.036\ (D_{50-54}+3.1528D_{55-60})$$

$$\widetilde{LFR}^{60+}_{f,r} = 0.333\ \widetilde{LFR}^{55-59}_{f,r} + 0.042$$

$$\widetilde{LFR}^{15-19}_{f,r} = 0.7795 - 2.6879\ TFR_a - 0.4032\ EDU_{18-19,f,r}$$

$$\widetilde{LFR}^{14}_{f,r} = 0.5\ \widetilde{LFR}^{15-19}_{f,r}$$

(b) Economically active population ($LFS_{a,s,g}$)

$$LFS_{a,m,g} = LFR_{a,m,g} \cdot (POP_{a,m,g} - SOL_{a,g})$$

$$LFS_{a,f,u} = LFR_{a,f,u}\quad POP_{a,f,u}$$

$$LFS_{a,f,r} = (\widetilde{LFR}_{a,f,r} - 0.045) \cdot POP_{a,f,r}$$

C. ECONOMIC SECTOR

1. The composition of GNP by expenditure sector

(a) Private consumption expenditure (CON_p)

$$\left(\frac{CON_p}{X}\right) = 0.011725 + 0.156724 \left(\frac{GNP}{X}\right) + 0.779824 \left(\frac{CON_p}{X}\right)_{-1}$$

$$X = NFM \left(\sum_a U_a \cdot FMS_a\right)^{\theta}$$

$U_{0-2} = 0.64286$, $U_{3-5} = 0.65578$, $U_{6-13} = 0.68456$

$U_{14+} = 1$ $\theta = 0.71092$

(b) Government consumption expenditure (CON_G)

$$CON_G = 0.152532 \; CON_p$$

(c) Gross capital formation (GCF)

$$GCF_t = GCFR_t \cdot GNP_t$$

(d) Balance of payment (BOP)

$$BOP_t = XPT_t - MPT_t$$

$$= BOPR_t \cdot GNP_t$$

(e) Determination of GNP and its expenditure components

$$GNP_t = \frac{k}{1 - GCFR_t - BOPR_t - \alpha(\beta+1)}$$

where $k = \left[0.011725 + 0.779824 \left(\frac{CON_p}{X}\right)_{t-1} \right] X_t \cdot (\beta+1)$

$\alpha = 0.156724$

$\beta = 0.152532$

(f) Import (MPT) and Export (XPT)

$$\ln \frac{MPT_c}{POP} = 1.30475 + 0.941146 \; \ln \frac{GNP}{POP} - 0.374635 \; \ln POP - 0.158624 \; \ln \frac{LND}{POP}$$

$$MPT = -122.1 + 1.25032 \; MPT_c$$

$$XPT = MPT + BOP$$

2. Value added by industry

(a) The conversion matrix (C_{ij})

$$\ln \hat{C}_{ij} = b_0 + b_1\, T \ :\ \text{for elements with declining trend}$$

$$\ln\, (1-\hat{C}_{ij}) = C_0 + C_1 T :\ \text{for elements with increasing trend}$$

$$C_{ij} = \hat{C}_{ij} \,/\, \Sigma_i\, \hat{C}_{ij}$$

(b) Value added by industry (VAD_i)

$$[VAD_i] = [C_{ij}] \cdot [GNPX_j]$$

3. Employment and productivity of labour

(a) Expected labour productivity ($\hat{APL}_i$) and labour demand (LFD_i) by industry

$$\hat{APL}_1 = -0.176065 + 0.0054083\ (T-1900) + 0.511565\ \hat{APL}_{1,t-1}$$

$$\hat{APL}_2 = -1.339 + 0.023853\ (T-1900) + 0.673587\ \hat{APL}_{2,t-1}$$

$$\hat{APL}_3 = -2.20595 + 0.044088\ (T-1900) + 0.052478\ \hat{APL}_{3,t-1}$$

$$LFD_i = VAD_i / \hat{APL}_i$$

(b) Employment (EMP_i) and actual productivity (APL_i) of labour (APL_i) by industry

$$EMP = \begin{cases} 0.97\,LFD & \text{if } LFD \geqslant LFS \\ 0.5\ (LFS-LFD) + 0.97\ LFD & \text{if } LFD < LFS \end{cases}$$

$$APL_i = \hat{APL}_i \cdot (EMP/LFD)$$

$$EMP_i = VAD_i / APL_i$$

$$APL = \sum_i APL_i \cdot (EMP_i / EMP)$$

(c) Employment (EMP_g) and the labour productivity (APL_g) by region

$$UMPR_r = [UMPR - 0.0171\ (LFS_u/LFS)] \,/\, [3.875\ (LFS_u/LFS) + (LFS_r/LFS)]$$

$$UMPR_u = 0.0171 + 3.875\ UMPR_r$$

$$EMP_r = LFS_r(1-UMPR_r)$$

$$EMP_u = LFS_u(1-UMPR_u)$$

$$EMP_{r,1} = 0.94\ EMP_1$$

$$EMP_{r,2} = 0.1\ EMP_{r,1}$$

$$EMP_{r,3} = EMP_r - EMP_{r,1} - EMP_{r,2}$$

$$EMP_{u,i} = EMP_i - EMP_{r,i}$$

$$APL_g = \sum_i APL_i\ (EMP_{g,i}/EMP_g)$$

APPENDIX II: LIST OF VARIABLES AND DATA SOURCES

Variable	Unit	Description	Data
ACB_g	year	Mean age at child birth	2
$AFR_{a,g}$	rate/1000	Age specific fertility rate	2
$APL_{g,i}$	mil won	Average productivity of labour	1
BOP	bil won	XPT-MPT	
(BOPR)	ratio	BOP/GNP	
$BTH_{s,g}$	1000 person	Number of births	
$(C_{i,j})$		Conversion matrix (expenditure into value added)	3
CBR_g	rate/1000	Crude birth rate	
CDR_g	rate/1000	Crude death rate	
CON_G	bil won	Government consumption expenditure	1
CON_p	bil won	Private consumption expenditure	1
DPR_g	ratio	Dependency ratio	
DTH_g	1000 person	Number of deaths	
$EDU_{a,s,g}$	ratio	Proportion high school graduates	4
(emi)	rate	Emigration rate	
$EMI_{a,s,g}$	1000 person	Number of emigrants	
$EMP_{g,i}$	1000 person	Number of employed persons	4
enr	ratio	Secondary school enrolment ratio	1, 5
e_o^s	year	Life expectancy at birth	5, 6, 7
$FMS_{a,s}$	Number	Average size of family	4, 8, 9, 10
GCF	bil won	Gross capital formation	1, 11
(GCFR)	ratio	GCF/GNP	
GNP	bil won	Gross national product	1
$GNPX_j$	bil won	Expenditure side GNP adjusted	
LFD_i	1000 person	Labour demand	
$LFR_{a,s,g}$	rate	Labour force participation rate	4, 12
$LFS_{a,s,g}$	1000 person	Economically active population	
(LND)	Km^2	National land area	1
$(m_{a,s})$	index	Migration propensity	13
$MBTH_s$	1000 person	Number of births born to migrants	
$MIG_{a,s}$	1000 person	Net migrants from rural to urban	
MPT	bil won	Total imports	1
MPT_c	bill won	Commodity imports	3
NFM_g	Number in 1000	Number of families	
NRR_g	rate/1000	Net rate of reproduction	
$POP_{a,s,g}$	1000 person	Population	14

Appendix II: List of variables and data sources *(cont'd)*

Variable	Unit	Description	Data
$Q_{a,s}$	rate	Survival rate	15
PCY	1000 $	*Per capita* GNP	
RNI_g	rate/1000	Natural growth rate of population	
$(SOL_{a,g})$	1000 person	Soldiers and other institutionalized population	3
SXR_g	ratio	Sex ratio (male/female)	
$(TFR_{a,g})$	rate/1000	Total fertility rate	2
$UMPR_g$	rate	Unemployment rate	16
URB	rate	Urbanization rate	4, 8
VAD_i	bil won	Value added	1
XPT	bil won	Total exports	1
XPT_c	bil won	Commodity exports	3

Notes: (1) A dot over a variable (e.g., $\dot{APL}$) indicates the annual rate of growth of the variable. The mark "~" over a variable indicates a preliminary estimate of the variable to be adjusted later.

(2) Notation of subscripts

s = sex (m = male, f = female)
a = age
g = region (u = urban, r = rural)
i = industry
j = expenditure sector

(3) Variables in parenthesis are exogenously determined; either given as constants or trends extrapolated by time

(4) All 1975 constant price

(5) Data sources

1. EPB, Handbook of Korean Economy 1980
2. KIFP, 1978
3. Unpublished KDI research materials
4. Population censuses, 1960, 1966, 1970, 1975
5. Japan Statistical Yearbook, 1960-76
6. Hong, 1978
7. BOS, Year-End Count of Population, various years
8. EPB, Annual Report on the Family Income and Expenditure Survey, various years
9. Ministry of Agriculture and Fisheries, Report on the Results of Farm Household Economy Survey, various years.
10. United Nations Statistical Yearbook, 1978
11. Kim, 1974
12. Kwon, 1975
13. BOS, Preliminary results of 1980 population census
14. BOS estimates
15. BOS, Annual Report on the Economically Active Population Survey

APPENDIX III: TABLES

Appendix table 1

Life expectancy at birth for selected countries

Year	e_o			Per capita GNP ($ 1970)
	Male	Female	Male/ Female	
Japan				
1952	61.9	65.5	0.95	445
1953	61.9	65.7	0.94	466
1954	63.4	67.7	0.94	486
1955	63.9	68.4	0.93	523
1956	63.6	67.5	0.94	555
1958	65.0	69.6	0.93	619
1959	65.2	69.9	0.93	667
1960	65.3	70.2	0.93	750
1962	66.2	71.2	0.93	901
1963	67.2	72.3	0.93	985
1965	67.7	73.0	0.93	1148
1970	69.3	74.7	0.93	1880
1972	70.5	75.9	0.93	2143
Republic of Korea				
1960	51.1	53.7	0.95	133
1966	59.7	64.1	0.93	170
1970	62.9	66.8	0.94	234
1975	65.2	69.6	0.94	342

Source: e_o : 1. Japan Statistical Yearbook 1973/74, p. 36.
2. Hong, 1978, p. 159.

Per capita GNP:
1. Japan calculated from 1970 constant GNP 1970 exchange rate population (to $US).
2. EPB, 1978.

Appendix table 2

Abridged life table for the Republic of Korea, 1978-1979

Male									Female								
AGE	Q(X)	D(X)	M(X)	1(X)	L(X)	S(X)	T(X)	E(X)	AGE	Q(X)	D(X)	M(X)	1(X)	L(X)	S(X)	T(X)	E(X)
0	0.03140	3 140	0.03228	100 000	97 277	0.96512*	6 269 734	62.70	0	0.04103	4 103	0.04247	100 000	96 607	0.95205*	6 907 122	69.07
1	0.00911	882	0.00229	96 860	385 285	0.99174**	6 172 458	63.73	1	0.01710	1 640	0.00432	95 897	379 418	0.98829**	6 810 515	71.02
5	0.00547	525	0.00110	95 978	478 575	0.99509	5 787 173	60.30	5	0.00354	334	0.00071	94 257	470 451	0.99693	6 431 097	68.23
10	0.00435	415	0.00087	95 453	476 225	0.99407	5 308 598	55.62	10	0.00259	243	0.00052	93 923	469 009	0.99656	5 960 646	63.46
15	0.00752	715	0.00151	95 037	473 400	0.99085	4 832 374	50.85	15	0.00429	402	0.00086	93 680	467 396	0.99500	5 491 638	58.62
20	0.01080	1 019	0.00217	94 323	469 066	0.98855	4 358 975	46.21	20	0.00571	533	0.00115	93 278	465 059	0.99422	5 024 243	53.86
25	0.01211	1 130	0.00244	93 304	463 695	0.98725	3 889 909	41.69	25	0.00585	543	0.00117	92 746	462 371	0.99410	4 559 184	49.16
30	0.01339	1 234	0.00270	92 174	457 784	0.98527	3 426 215	37.17	30	0.00595	549	0.00119	92 203	459 643	0.99234	4 096 813	44.43
35	0.01609	1 463	0.00324	90 940	451 041	0.97641	2 968 431	32.64	35	0.00937	859	0.00188	91 654	456 125	0.98728	3 637 170	39.68
40	0.03122	2 793	0.00634	89 477	440 399	0.96274	2 517 391	28.13	40	0.01611	1 463	0.00325	90 796	450 321	0.98132	3 181 046	35.04
45	0.04349	3 770	0.00889	86 683	423 990	0.94541	2 076 993	23.96	45	0.02129	1 902	0.00430	89 333	441 909	0.97400	2 730 726	30.57
50	0.06620	5 489	0.01369	82 913	400 843	0.91598	1 653 003	19.94	50	0.03081	2 694	0.00626	87 431	430 420	0.96164	2 288 817	26.18
55	0.10310	7 982	0.02174	77 424	367 165	0.86376	1 252 160	16.17	55	0.04614	3 910	0.00945	84 737	413 911	0.93951	1 858 397	21.93
60	0.17319	12 027	0.03792	69 442	317 143	0.78085	884 995	12.74	60	0.07553	6 105	0.01570	80 827	388 874	0.90125	1 444 486	17.87
65	0.27474	15 774	0.06370	57 415	247 640	0.68354	567 853	9.89	65	0.12387	9 256	0.02641	74 722	350 472	0.82912	1 055 612	14.13
70	0.37398	15 573	0.09200	41 641	169 273	0.56618	320 213	7.69	70	0.22454	14 700	0.05059	65 467	290 583	0.73235	705 140	10.77
75	0.52941	13 801	0.14400	26 068	95 839	0.36506	150 940	5.79	75	0.32325	16 410	0.07711	50 767	212 808	0.48666	414 557	8.17
80	1.00000	12 267	0.22263	12 267	55 101	0.00000	55 101	4.49	80	1.00000	34 356	0.17029	34 356	201 750	0.00000	201 750	5.87

Source: BOS, 1980. * P(birth) ** P(0-4)

Appendix table 3

Model life tables for the Republic of Korea

	Female						Male				
e_o^f	69.1	70	72.5	75.0	77.5	e_o^m	62.7	63.6	66.0	68.2	71.7
0	.96607	.96940	.97764	.98739	.99271	0	.97277	.97641	.98458	.98724	.98724
1	.98829	.98537	.98309	.98760	.99244	1	.99174	.99151	.99262	.99457	.99457
5	.99693	.99722	.99098	.99880	.99905	5	.99509	.99559	.99694	.99820	.99872
10	.99656	.99744	.99893	.99912	.99912	10	.99407	.99522	.99754	.99836	.99861
15	.99500	.99605	.99818	.99875	.99875	15	.99085	.99235	.99553	.99751	.99758
20	.99422	.99522	.99770	.99849	.99849	20	.98855	.98995	.99325	.99652	.99699
25	.99410	.99529	.99764	.99820	.99820	25	.98725	.98880	.99245	.99613	.99678
30	.99234	.99416	.99718	.99754	.99754	30	.98527	.98736	.99205	.99596	.99596
35	.98728	.98996	.99492	.99635	.99635	35	.97641	.98086	.98933	.99290	.99406
40	.98132	.98407	.98998	.99357	.99357	40	.96274	.96705	.97564	.98212	.99132
45	.97400	.97803	.98644	.98903	.98903	45	.94541	.95192	.96406	.97186	.98462
50	.96164	.96735	.97883	.98180	.98180	50	.91598	.92507	.94140	.95044	.96965
55	.93951	.94860	.96585	.97046	.97046	55	.86376	.87857	.90372	.91421	.95958
60	.90125	.91493	.94102	.94900	.94900	60	.78085	.80002	.83187	.84385	.89903
65	.82912	.85226	.89386	.90724	.90724	65	.68354	.70308	.73770	.75497	.81063
70	.73235	.75145	.78592	.81036	.84741	70	.56618	.59276	.63842	.65908	.72088
75+	.48666	.55119	.65372	.67799	.67799	75+	.36506	.40175	.46077	.47781	.54362

Appendix table 4

Enrolment rate and the proportion of eligible age population

Year	Enrolment rate			$\frac{POP_{13\text{-}18}}{POP_{20+}}$	*Per capita* GNP (1975, 1000$)
	Primary	Secondary	College		
Republic of Korea					
1964	1.097	.335	.046	.240	.271
1965	1.050	.355	.048	.246	.280
1966	1.026	.367	.059	.248	.307
1967	1.012	.379	.059	.252	.320
1968	1.012	.392	.054	.263	.348
1969	1.001	.410	.057	.275	.387
1970	1.008	.436	.060	.287	.408
1971	1.027	.470	.061	.296	.437
1972	1.036	.488	.064	.311	.454
1973	1.041	.514	.068	.319	.513
1974	1.043	.546	.072	.319	.544
1975	1.033	.580	.075	.313	.574
1976		.608		.309	.650
1977		.636		.305	.705
1978		.679		.288	.776
Japan					
1960		.777		.210	.712
1965		.855		.207	1.163
1970		.920		.140	1.882
1971		.918		.136	2.035
1972		.914		.133	2,135
1973		.941		.129	2.322
1974		.949		.126	2.438
1975		.947		.125	2.407
1976		.950		.125	2.455

Appendix table 5

Labour force participation rates by sex and region

Unit: %

Sex	Region	Year	14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60+
Male	Urban	1966	19.2	43.9	75.5	95.6	98.5	98.6	98.2	97.4	93.2	80.6	35.1
		1970	13.0	36.3	47.6	85.2	95.5	96.2	95.3	93.9	87.2	74.3	43.0
		1974	10.3	32.1	70.5	93.6	98.5	98.4	97.4	95.6	88.1	70.8	31.8
		1975	12.0	38.5	75.9	94.7	98.5	98.6	97.9	96.1	90.0	74.9	33.7
	Rural	1966	29.6	58.7	84.7	92.5	94.0	93.5	94.1	93.7	91.9	86.6	45.8
		1970	23.5	55.5	52.9	86.2	95.6	96.9	96.4	96.1	94.4	90.4	50.6
		1974	22.0	52.2	88.8	96.9	98.5	98.2	98.0	96.7	94.0	90.4	55.0
		1975	22.9	56.5	93.9	97.8	98.4	98.5	98.0	97.3	96.4	91.7	55.1
Female	Urban	1966	19.2	37.8	38.1	18.0	16.9	21.6	24.8	24.7	19.8	14.8	4.8
		1970	17.5	39.1	39.2	17.8	17.1	22.1	26.8	27.8	22.1	16.5	7.6
		1974	17.1	39.1	48.5	19.8	22.1	29.5	32.6	33.1	26.9	18.8	5.6
		1975	17.7	44.5	49.7	20.4	20.8	26.4	30.5	31.3	25.7	19.1	5.9
	Rural	1966	16.3	28.8	35.0	36.7	41.9	46.7	49.3	48.4	42.9	35.8	12.0
		1970	20.9	41.7	49.6	46.7	52.2	58.1	60.5	60.6	57.0	49.9	20.9
		1974	22.6	44.2	55.0	49.2	57.5	66.0	71.1	69.7	65.5	57.3	24.1
		1975	26.3	52.0	66.8	60.0	68.8	76.0	80.7	81.3	78.3	70.4	26.7

Source: Census: 1960, 1966, 1970, 1975
Kim, Sookon, 1974, pp. 126-127.

Appendix table 6

Population in thousand (urban): basic prospect

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
MALE																	
0 – 4	1 308	1 371	1 434	1 490	1 529	1 579	1 622	1 655	1 677	1 689	1 691	1 684	1 686	1 692	1 692	1 705	1 809
5 – 9	1 249	1 217	1 198	1 215	1 269	1 325	1 390	1 457	1 514	1 553	1 648	1 703	1 722	1 722	1 722	1 722	1 724
10 – 14	1 258	1 304	1 329	1 336	1 319	1 288	1 258	1 243	1 260	1 313	1 434	1 556	1 647	1 729	1 769	1 773	1 765
15 – 19	1 383	1 328	1 275	1 271	1 313	1 374	1 430	1 468	1 477	1 460	1 390	1 376	1 485	1 622	1 719	1 886	1 888
20 – 24	1 344	1 436	1 506	1 544	1 515	1 461	1 417	1 388	1 392	1 439	1 558	1 598	1 537	1 477	1 538	1 810	1 973
25 – 29	1 148	1 179	1 197	1 247	1 330	1 429	1 530	1 610	1 649	1 625	1 540	1 522	1 636	1 738	1 716	1 636	1 890
30 – 34	917	955	1 001	1 055	1 120	1 192	1 235	1 275	1 338	1 430	1 633	1 746	1 686	1 639	1 705	1 820	1 710
35 – 39	761	784	817	861	905	933	973	1 025	1 082	1 150	1 273	1 388	1 585	1 765	1 785	1 765	1 864
40 – 44	672	704	726	740	746	759	783	820	865	908	977	1 085	1 230	1 333	1 502	1 798	1 782
45 – 49	488	524	558	595	626	659	692	717	729	735	772	852	923	1 015	1 141	1 491	1 783
50 – 54	314	339	363	390	427	467	502	536	572	602	665	700	719	779	863	1 103	1 450
55 – 59	238	242	248	259	272	289	312	336	361	396	466	531	589	642	657	807	1 036
60 – 64	157	167	180	192	200	204	208	214	224	236	271	315	378	435	490	577	712
65 +	195	203	210	217	227	238	251	266	281	293	316	349	385	437	503	710	917
TOTAL	11 433	11 752	12 042	12 412	12 795	13 196	13 603	14 010	14 420	14 830	15 633	16 403	17 209	18 023	18 804	20 604	22 302
6 – 11	1 552	1 527	1 491	1 470	1 477	1 521	1 571	1 638	1 715	1 794	1 906	2 006	2 064	2 084	2 085	2 086	2 073
12 – 14	724	761	794	817	821	806	779	753	738	744	834	911	965	1 027	1 064	1 069	1 069
15 – 17	768	729	727	761	804	847	872	876	861	833	787	820	924	980	1 046	1 120	1 116
18 – 21	1 231	1 229	1 170	1 116	1 071	1 053	1 084	1 136	1 192	1 237	1 247	1 174	1 133	1 220	1 330	1 515	1 560
FEMALE																	
0 – 4	1 227	1 289	1 352	1 406	1 446	1 493	1 534	1 566	1 587	1 598	1 600	1 594	1 597	1 605	1 607	1 623	1 725
5 – 9	1 147	1 120	1 117	1 136	1 184	1 236	1 300	1 367	1 422	1 463	1 552	1 604	1 623	1 623	1 624	1 630	1 637
10 – 14	1 138	1 187	1 201	1 216	1 207	1 186	1 161	1 162	1 180	1 227	1 343	1 463	1 553	1 631	1 669	1 674	1 672
15 – 19	1 322	1 246	1 182	1 170	1 210	1 268	1 329	1 354	1 369	1 360	1 301	1 303	1 402	1 538	1 636	1 793	1 797
20 – 24	1 487	1 541	1 563	1 555	1 497	1 433	1 335	1 342	1 343	1 389	1 509	1 536	1 488	1 444	1 491	1 757	1 909
25 – 29	1 131	1 213	1 296	1 392	1 472	1 545	1 606	1 643	1 641	1 594	1 489	1 466	1 573	1 655	1 641	1 572	1 824
30 – 34	828	866	902	958	1 055	1 158	1 244	1 337	1 435	1 517	1 654	1 692	1 599	1 535	1 593	1 699	1 609
35 – 39	692	713	741	778	811	838	878	918	975	1 074	1 265	1 457	1 613	1 717	1 681	1 629	1 723
40 – 44	611	640	663	675	682	695	716	746	784	818	885	982	1 186	1 369	1 551	1 693	1 644
45 – 49	472	499	528	559	582	611	641	665	677	685	718	786	848	928	1 085	1 549	1 691
50 – 54	358	376	395	413	442	470	498	528	560	583	642	677	696	747	819	1 079	1 536
55 – 59	281	291	302	318	336	353	373	393	412	441	497	558	610	664	681	810	1 063
60 – 64	206	217	232	248	261	272	283	296	312	330	367	406	463	521	574	666	788
65 +	387	405	419	437	456	480	506	534	563	592	655	729	811	907	1 019	1 349	1 691
TOTAL	11 287	11 603	11 893	12 260	12 640	13 039	13 443	13 849	14 260	14 670	15.477	16 253	17 064	17 882	18 672	20 524	22 311
6 – 11	1 417	1 401	1 372	1 355	1 380	1 421	1 469	1 532	1 607	1 684	1,795	1 889	1 944	1 964	1 965	1 972	1 966
12 – 14	650	690	721	750	742	733	713	707	693	696	779	855	910	969	1 004	1 009	1 012
15 – 17	717	671	664	693	739	780	810	802	792	770	745	771	871	931	993	1 063	1 061
18 – 21	1 240	1 207	1 132	1 065	1 010	990	1 016	1 067	1 124	1 170	1 173	1 111	1 086	1 161	1 271	1 451	1 494
BOTH SEXES																	
0 – 4	2 535	2 660	2 786	2 896	2 975	3 072	3 156	3 221	3 264	3 288	3 291	3 277	3 284	3 297	3 299	3 328	3 534
5 – 9	2 396	2 337	2 315	2 351	2 452	2 561	2 690	2 824	2 936	3 016	3 199	3 308	3 345	3 345	3 346	3 353	3 362
10 – 14	2 396	2 491	2 529	2 552	2 526	2 474	2 418	2 405	2 440	2 541	2 777	3 018	3 200	3 360	3 438	3 446	3 437
15 – 19	2 705	2 574	2 457	2 442	2 523	2 642	2 758	2 821	2 846	2 819	2 690	2 679	2 887	3 160	3 356	3 679	3 686
20 – 24	2 831	2 977	3 069	3 099	3 012	2 894	2 793	2 730	2 736	2 828	3 067	3 134	3 025	2 921	3 030	3 567	3 882
25 – 29	2 279	2 392	2 493	2 639	2 802	2 974	3 136	3 253	3 290	3 220	3 030	2 988	3 209	3 392	3 357	3 208	3 714
30 – 34	1 745	1 820	1 904	2 014	2 176	2 351	2 479	2 612	2 773	2 947	3 287	3 437	3 286	3 174	3 298	3 520	3 319
35 – 39	1 454	1 497	1 558	1 640	1 716	1 772	1 851	1 943	2 057	2 224	2 538	2 844	3 198	3 482	3 467	3 394	3 587
40 – 44	1 283	1 344	1 390	1 414	1 428	1 454	1 500	1 566	1 649	1 727	1 862	2 067	2 416	2 702	3 052	3 492	3 426
45 – 49	961	1 023	1 086	1 154	1 208	1 270	1 333	1 382	1 406	1 420	1 491	1 639	1 771	1 943	2 226	3 041	3 474
50 – 54	672	715	758	803	869	937	1 000	1 064	1 131	1 185	1 308	1 377	1 416	1 526	1 682	2 182	2 986
55 – 59	518	533	550	577	608	642	685	728	773	837	963	1 089	1 200	1 305	1 339	1 617	2 099
60 – 64	363	384	412	440	460	476	491	510	536	566	638	720	841	956	1 064	1 243	1 500
65 +	583	608	629	654	682	717	757	800	844	884	971	1 078	1 196	1 343	1 522	2 059	2 607
TOTAL	22 721	23 355	23 935	24 672	25 436	26 235	27 046	27 859	28 680	29 500	31 110	32 656	34 273	35 905	37 476	41 127	44 613
6 – 11	2 969	2 928	2 863	2 826	2 857	2 942	3 040	3 170	3 322	3 478	3 701	3 895	4 008	4 048	4 050	4 058	4 039
12 – 14	1 375	1 451	1 515	1 567	1 563	1 539	1 492	1 459	1 432	1 440	1 613	1 766	1 875	1 996	2 069	2 079	2 081
15 – 17	1 485	1 400	1 391	1 453	1 543	1 627	1 682	1 678	1 653	1 603	1 531	1 591	1 795	1 910	2 040	2 183	2 177
18 – 21	2 471	2 436	2 302	2 182	2 081	2 043	2 100	2 202	2 316	2 406	2 420	2 285	2 219	2 381	2 601	2 965	3 053

Appendix table 7

Population in thousand (rural): basic prospect

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
MALE																	
0 – 4	807	786	771	754	739	728	720	714	710	706	698	685	655	608	547	390	291
5 – 9	978	922	871	826	792	765	742	724	706	690	671	661	651	636	613	498	352
10 – 14	1 087	1 078	1 063	1 023	973	919	861	808	763	730	681	647	619	599	586	546	440
15 – 19	920	985	965	978	968	947	928	900	860	811	711	629	570	524	490	452	412
20 – 24	841	841	825	794	797	812	817	824	830	816	774	714	627	537	470	380	346
25 – 29	526	570	636	690	716	725	715	689	658	657	667	674	633	581	510	354	281
30 – 34	425	417	417	422	439	455	487	531	571	589	583	534	532	523	501	385	263
35 – 39	402	392	390	394	391	385	376	369	372	385	424	496	513	477	443	417	317
40 – 44	463	457	440	413	390	372	361	356	359	355	340	336	358	411	451	391	366
45 – 49	432	443	449	446	439	430	424	406	380	358	331	329	320	304	315	409	354
50 – 54	314	323	340	360	381	399	409	414	411	404	390	350	315	301	299	289	377
55 – 59	293	289	285	280	279	282	291	306	324	343	368	370	357	336	297	270	263
60 – 64	236	239	244	248	249	247	244	240	237	236	246	275	305	316	309	253	232
65 +	361	365	369	373	377	383	389	395	401	405	410	413	419	438	465	516	505
TOTAL	8 085	8 057	8 065	8 001	7 932	7 850	7 764	7 676	7 583	7 486	7 293	7 114	6 874	6 591	6 296	5 550	4 800
6 – 11	1 243	1 182	1 127	1 061	1 003	955	915	885	859	837	802	783	768	752	732	625	455
12 – 14	648	651	648	632	609	581	544	505	472	445	413	391	369	355	346	327	273
15 – 17	585	603	609	603	599	586	569	546	519	483	417	378	349	323	306	288	260
18 – 21	667	655	680	695	708	716	707	694	678	661	601	526	454	404	367	319	296
FEMALE																	
0 – 4	751	732	720	709	699	689	681	676	672	668	661	648	621	576	520	371	277
5 – 9	917	858	815	763	731	710	690	675	663	652	634	625	615	602	581	473	336
10 – 14	1 054	1 042	1 014	972	920	862	803	757	706	674	634	608	585	566	554	517	418
15 – 19	816	859	908	933	925	907	884	845	803	753	649	571	518	476	450	415	379
20 – 24	596	603	617	627	658	686	712	731	743	729	687	620	532	449	384	315	284
25 – 29	476	491	513	525	524	519	519	519	523	544	581	605	570	512	441	290	233
30 – 34	407	405	402	405	418	434	444	457	465	462	454	456	487	506	494	367	239
35 – 39	404	383	379	379	380	383	379	373	375	386	408	426	416	409	422	440	326
40 – 44	477	473	459	435	410	383	363	357	356	356	355	350	372	388	390	387	403
45 – 49	460	463	466	466	463	455	450	435	412	387	343	336	338	327	336	363	359
50 – 54	389	402	411	421	429	437	439	440	440	436	424	388	341	316	313	313	336
55 – 59	336	338	343	347	353	364	376	383	392	399	408	409	398	379	336	288	287
60 – 64	264	271	282	295	304	307	308	312	315	321	342	358	370	371	366	302	258
65 +	555	570	584	594	607	623	641	660	678	696	727	762	800	840	878	953	948
TOTAL	7 900	7 890	7 914	7 870	7 820	7 757	7 689	7 620	7 544	7 464	7 307	7 163	6 962	6 720	6 465	5 795	5 081
6 – 11	1 175	1 113	1 056	939	935	883	848	824	801	783	758	740	726	712	693	594	433
12 – 14	636	632	625	604	575	550	508	473	437	413	380	366	348	335	327	309	259
15 – 17	538	569	584	587	576	560	538	510	485	446	381	345	318	299	284	266	241
18 – 21	527	545	588	620	648	665	665	652	632	611	546	468	400	352	321	282	261
BOTH SEXES																	
0 – 4	1 558	1 518	1 491	1 463	1 437	1 417	1 401	1 390	1 382	1 375	1 359	1 333	1 276	1 184	1 067	761	568
5 – 9	1 895	1 780	1 686	1 589	1 524	1 475	1 432	1 398	1 369	1 342	1 304	1 286	1 266	1 239	1 194	971	688
10 – 14	2 140	2 120	2 077	1 995	1 894	1 780	1 664	1 564	1 470	1 405	1 315	1 255	1 203	1 165	1 140	1 062	857
15 – 19	1 736	1 794	1 873	1 911	1 894	1 854	1 811	1 745	1 662	1 565	1 360	1 200	1 088	1 000	939	867	791
20 – 24	1 437	1 444	1 443	1 422	1 456	1 498	1 529	1 555	1 573	1 545	1 461	1 334	1 159	985	855	695	630
25 – 29	1 002	1 060	1 149	1 215	1 241	1 243	1 234	1 208	1 182	1 201	1 248	1 279	1 203	1 093	951	644	515
30 – 34	832	822	819	826	857	889	932	988	1 036	1 051	1 037	989	1 019	1 029	995	752	501
35 – 39	806	775	769	773	771	768	755	743	746	770	832	922	928	886	865	857	643
40 – 44	940	930	899	848	799	755	724	714	715	712	696	687	731	800	841	778	769
45 – 49	892	905	915	912	902	885	874	841	792	745	674	665	658	632	651	772	713
50 – 54	702	725	751	782	810	836	847	854	851	840	814	738	655	616	612	602	713
55 – 59	629	627	627	627	632	646	666	689	717	742	776	780	755	715	633	558	549
60 – 64	499	510	526	543	552	554	552	552	552	557	588	633	675	688	675	555	490
65 +	916	936	954	966	984	1 006	1 031	1 055	1 079	1 101	1 137	1 175	1 220	1 278	1 344	1 470	1 453
TOTAL	15 986	15 948	15 979	15 870	15 752	15 607	15 453	15 296	15 126	14 951	14 601	14 277	13 837	13 310	12 761	11 344	9 881
6 – 11	2 418	2 295	2 182	2 049	1 938	1 838	1 763	1 709	1 660	1 620	1 561	1 522	1 494	1 464	1 425	1 219	888
12 – 14	1 284	1 282	1 273	1 236	1 184	1 131	1 052	978	909	858	793	756	717	690	673	637	532
15 – 17	1 124	1 172	1 193	1 190	1 175	1 146	1 107	1 056	1 003	928	798	723	667	622	590	554	501
18 – 21	1 194	1 199	1 267	1 315	1 356	1 381	1 373	1 346	1 311	1 272	1 146	995	854	756	688	601	557

Appendix table 8

Population in thousand (total): basic prospect

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
MALE																	
0 – 4	2 116	2 157	2 205	2 244	2 268	2 307	2 342	2 369	2 388	2 396	2 390	2 368	2 341	2 300	2 239	2 095	2 099
5 – 9	2 227	2 138	2 069	2 040	2 061	2 090	2 132	2 180	2 220	2 244	2 318	2 364	2 373	2 358	2 335	2 220	2 077
10 – 14	2 345	2 382	2 392	2 359	2 292	2 207	2 119	2 051	2 023	2 044	2 115	2 203	2 266	2 328	2 356	2 318	2 205
15 – 19	2 303	2 263	2 240	2 249	2 281	2 321	2 358	2 368	2 337	2 271	2 100	2 006	2 056	2 146	2 209	2 338	2 301
20 – 24	2 186	2 277	2 331	2 339	2 312	2 273	2 235	2 213	2 223	2 255	2 332	2 312	2 164	2 013	2 008	2 190	2 319
25 – 29	1 674	1 740	1 833	1 937	2 046	2 154	2 245	2 299	2 307	2 282	2 207	2 196	2 269	2 318	2 226	1 990	2 171
30 – 34	1 343	1 372	1 418	1 477	1 559	1 648	1 723	1 806	1 910	2 019	2 216	2 279	2 218	2 162	2 206	2 205	1 972
35 – 39	1 163	1 176	1 207	1 255	1 296	1 319	1 349	1 395	1 454	1 535	1 698	1 883	2 097	2 242	2 228	2 182	2 181
40 – 44	1 135	1 161	1 168	1 153	1 135	1 131	1 144	1 176	1 224	1 264	1 317	1 421	1 588	1 744	1 953	2 189	2 148
45 – 49	920	967	1 007	1 041	1 065	1 089	1 115	1 123	1 109	1 093	1 103	1 181	1 243	1 319	1 456	1 900	2 137
50 – 54	628	662	703	750	808	866	911	949	983	1 006	1 055	1 050	1 034	1 079	1 162	1 393	1 827
55 – 59	531	531	533	539	551	571	603	641	685	739	834	901	946	978	954	1 077	1 299
60 – 64	393	406	424	440	448	451	452	454	461	472	517	590	683	751	799	830	944
65 +	556	568	579	590	604	621	640	662	682	698	726	762	804	874	968	1 227	1 422
TOTAL	19 519	19 809	20 106	20 413	20 727	21 046	21 366	21 686	22 003	22 316	22 927	23 517	24 083	24 613	25 100	26 153	27 102
6 – 11	2 795	2 709	2 617	2 531	2 480	2 475	2 486	2 523	2 574	2 631	2 709	2 788	2 832	2 836	2 817	2 711	2 527
12 – 14	1 373	1 411	1 442	1 449	1 430	1 387	1 323	1 257	1 210	1 189	1 247	1 302	1 334	1 382	1 411	1 396	1 342
15 – 17	1 353	1 332	1 335	1 364	1 402	1 433	1 440	1 422	1 379	1 316	1 204	1 198	1 273	1 302	1 353	1 408	1 376
18 – 21	1 898	1 884	1 850	1 811	1 779	1 769	1 792	1 830	1 870	1 897	1 848	1 701	1 587	1 623	1 697	1 834	1 856
FEMALE																	
0 – 4	1 977	2 021	2 072	2 115	2 145	2 182	2 215	2 241	2 259	2.267	2 261	2 242	2 218	2 181	2 126	1 994	2 002
5 – 9	2 063	1 978	1 933	1 900	1 915	1 946	1 991	2 042	2 085	2 115	2 185	2 229	2 238	2 225	2 205	2 103	1 973
10 – 14	2 192	2 229	2 215	2 188	2 128	2 048	1 963	1 919	1 886	1 901	1 977	2 070	2 137	2 197	2 223	2 190	2 090
15 – 19	2 138	2 105	2 090	2 103	2 135	2 175	2 212	2 199	2 172	2 113	1 950	1 874	1 920	2 014	2 086	2 208	2 176
20 – 24	2 083	2 144	2 180	2 182	2 156	2 119	2 087	2 073	2 087	2 119	2 196	2 156	2 020	1 893	1 876	2 072	2 193
25 – 29	1 607	1 703	1 809	1 916	1 996	2 064	2 125	2 162	2 164	2 138	2 071	2 071	2 143	2 167	2 083	1 862	2 057
30 – 34	1 235	1 271	1 305	1 363	1 474	1 592	1 688	1 794	1 900	1 979	2 108	2 147	2 086	2 041	2 087	2 067	1 848
35 – 39	1 096	1 097	1 120	1 157	1 191	1 221	1 257	1 291	1 349	1 460	1 672	1 883	2 029	2 126	2 103	2 069	2 049
40 – 44	1 088	1 113	1 122	1 110	1 092	1 078	1 080	1 104	1 141	1 174	1 241	1 333	1 559	1 757	1 940	2 081	2 047
45 – 49	933	962	994	1 025	1 044	1 066	1 091	1 100	1 089	1 072	1 061	1 123	1 186	1 256	1 421	1 912	2 050
50 – 54	747	778	806	834	871	907	937	969	1 000	1 019	1 066	1 065	1 037	1 063	1 132	1 392	1 873
55 – 59	616	629	645	665	688	717	749	776	804	840	906	968	1 009	1 043	1 017	1 098	1 350
60 – 64	469	489	514	542	564	578	591	608	627	651	709	763	833	892	940	968	1 046
65 +	943	975	1 004	1 030	1 063	1 103	1 147	1 194	1 241	1 287	1 381	1 491	1 612	1 747	1 897	2 302	2 638
TOTAL	19 187	19 494	19 807	20 130	20 461	20 796	21 133	21 469	21 804	22 135	22 784	23 416	24 026	24 602	25 137	26 318	27 392
6 – 11	2 592	2 514	2 428	2 344	2 315	2 304	2 317	2 356	2 408	2 467	2 554	2 629	2 671	2 676	2 659	2 566	2 400
12 – 14	1 286	1 322	1 346	1 354	1 318	1 282	1 221	1 180	1 131	1 109	1 159	1 221	1 259	1 304	1 331	1 319	1 272
15 – 17	1 256	1 240	1 249	1 280	1 315	1 340	1 348	1 312	1 277	1 216	1 126	1 116	1 189	1 230	1 277	1 329	1 301
18 – 21	1 767	1 752	1 720	1 685	1 658	1 655	1 681	1 719	1 756	1 781	1 718	1 579	1 486	1 513	1 591	1 733	1 755
BOTH SEXES																	
0 – 4	4 093	4 178	4 277	4 359	4 412	4 489	4 557	4 611	4 646	4 663	4 651	4 610	4 559	4 481	4 366	4 088	4 102
5 – 9	4 291	4 116	4 001	3 940	3 976	4 036	4 122	4 222	4 305	4 358	4 503	4 594	4 611	4 583	4 539	4 324	4 050
10 – 14	4 537	4 611	4 606	4 547	4 420	4 255	4 083	3 969	3 909	3 945	4 091	4 273	4 403	4 525	4 579	4 509	4 295
15 – 19	4 441	4 368	4 330	4 352	4 416	4 495	4 570	4 567	4 508	4 384	4 050	3 879	3 975	4 160	4 295	4 546	4 477
20 – 24	4 268	4 421	4 511	4 521	4 468	4 392	4 321	4 285	4 309	4 374	4 528	4 468	4 184	3 906	3 884	4 262	4 512
25 – 29	3 281	3 452	3 642	3 853	4 042	4 217	4 370	4 461	4 472	4 420	4 278	4 268	4 412	4 485	4 309	3 853	4 229
30 – 34	2 578	2 643	2 723	2 840	3 033	3 240	3 411	3 600	3 810	3 998	4 324	4 427	4 305	4 204	4 294	4 272	3 820
35 – 39	2 259	2 272	2 327	2 412	2 487	2 540	2 606	2 686	2 803	2 995	3 370	3 767	4 126	4 368	4 331	4 251	4 230
40 – 44	2 224	2 275	2 289	2 262	2 227	2 210	2 224	2 280	2 364	2 438	2 558	2 754	3 147	3 501	3 893	4 270	4 195
45 – 49	1 853	1 929	2 001	2 066	2 109	2 155	2 206	2 223	2 198	2 165	2 165	2 304	2 430	2 575	2 876	3 812	4 188
50 – 54	1 374	1 440	1 509	1 584	1 679	1 773	1 847	1 918	1 982	2 025	2 122	2 116	2 071	2 143	2 295	2 784	3 700
55 – 59	1 148	1 161	1 177	1 204	1 240	1 288	1 351	1 417	1 489	1 579	1 739	1 869	1 954	2 021	1 971	2 175	2 649
60 – 64	862	895	938	982	1 013	1 030	1 044	1 062	1 088	1 122	1 227	1 354	1 517	1 643	1 739	1 798	1 990
65 +	1 499	1 543	1 583	1 620	1 666	1 723	1 787	1 856	1 923	1 985	2 107	2 253	2 416	2 622	2 866	3 528	4 060
TOTAL	38 706	39 302	39 914	40 543	41 188	41 841	42 499	43 155	43 807	44 451	45 711	46 933	48 109	49 215	50 236	52 472	54 495
5 – 11	5 387	5 223	5 045	4 875	4 795	4 779	4 803	4 879	4 982	5 099	5 262	5 417	5 503	5 512	5 476	5 277	4 927
12 – 14	2 659	2 733	2 788	2 803	2 748	2 670	2 544	2 438	2 340	2 298	2 406	2 522	2 593	2 685	2 742	2 715	2 614
15 – 17	2 608	2 572	2 584	2 643	2 718	2 773	2 789	2 734	2 656	2 531	2 329	2 314	2 462	2 532	2 630	2 737	2 677
18 – 21	3 665	3 636	3 570	3 497	3 437	3 424	3 473	3 548	3 626	3 678	3 566	3 280	3 073	3 136	3 288	3 567	3 610

Appendix table 9

Vital rates and composition (urban): basic prospect

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
FERTILITY																		
15 – 19	RATE	0.069	0.068	0.068	0.067	0.067	0.067	0.067	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.067	0.067	0.068
20 – 24	RATE	0.658	0.0654	0.650	0.646	0.642	0.640	0.637	0.635	0.633	0.631	0.629	0.627	0.626	0.626	0.626	0.626	0.627
25 – 29	RATE	1.073	1.057	1.042	1.028	1.015	1.003	0.992	0.982	0.973	0.964	0.949	0.936	0.924	0.915	0.907	0.891	0.881
30 – 34	RATE	0.572	0.556	0.541	0.528	0.516	0.504	0.494	0.484	0.475	0.467	0.453	0.441	0.430	0.421	0.414	0.400	0.390
35 – 39	RATE	0.108	0.100	0.093	0.087	0.081	0.076	0.072	0.068	0.065	0.061	0.056	0.051	0.048	0.044	0.042	0.037	0.034
40 – 44	RATE	0.051	0.049	0.047	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037	0.037	0.036	0.036
TFR	RATE	2.530	2.483	2.440	2.401	2.366	2.334	2.304	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.036
ACB	AGE	27.3	27.2	27.1	27.1	27.0	27.0	27.0	26.9	26.9	26.8	26.8	26.7	26.7	26.6	26.6	26.5	26.5
CBR	1/1000	25.2	25.1	25.5	25.6	25.4	25.2	24.7	24.1	23.4	22.6	21.2	20.2	19.3	18.4	17.6	16.6	16.5
MORTALITY																		
LIFE EXP (F)	YEAR	69.6	70.0	70.4	71.1	71.4	71.7	72.1	72.4	72.6	72.9	73.4	73.9	74.3	74.7	75.1	75.9	76.5
LIFE EXP (M)	YEAR	63.2	63.6	64.0	64.7	65.0	65.3	65.6	65.9	66.2	66.4	66.9	67.3	67.6	68.0	68.2	69.0	69.7
CDR	1/1000	5.1	5.0	4.9	4.8	4.7	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.6	4.7	4.8	5.3	5.8
GROWTH RATE	1/1000	19.0	19.0	19.4	19.7	19.7	19.5	19.0	18.5	17.7	17.0	15.6	14.6	13.7	12.7	11.7	10.2	9.5
RNI	1/1000	20.1	20.1	20.5	20.8	20.8	20.6	20.1	19.6	18.8	18.1	16.7	15.7	14.8	13.8	12.8	11.3	10.6
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
NRR	NUMBER	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.99	0.98	0.97
NET MIGRATION	RATE	0.021	0.009	0.005	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.010	0.009	0.011	0.010	0.009	0.007	0.006
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.681	0.696	0.712	0.730	0.746	0.784	0.819
SEX RATIO	RATIO	1.013	1.013	1.013	1.012	1.012	1.012	1.012	1.012	1.011	1.011	1.010	1.009	1.009	1.008	1.007	1.004	1.000
M2531/F2127	RATIO	0.797	0.780	0.787	0.802	0.835	0.893	0.958	1.030	1.093	1.125	1.099	1.035	1.031	1.105	1.152	0.982	0.986
DEPENDENCY	RATIO	0.534	0.530	0.527	0.521	0.514	0.507	0.500	0.497	0.494	0.492	0.490	0.486	0.474	0.462	0.449	0.421	0.409
YOUNG (14–)	RATIO	0.495	0.491	0.487	0.481	0.473	0.466	0.458	0.454	0.450	0.447	0.444	0.437	0.423	0.407	0.390	0.350	0.326
OLD (65 +)	RATIO	0.039	0.040	0.040	0.040	0.041	0.041	0.042	0.043	0.044	0.045	0.047	0.049	0.051	0.055	0.059	0.071	0.082
F1544/F TOTAL	RATIO	0.538	0.536	0.534	0.532	0.532	0.532	0.532	0.530	0.529	0.528	0.524	0.519	0.519	0.518	0.514	0.494	0.471
F1524/F1544	RATIO	0.463	0.448	0.433	0.417	0.402	0.389	0.378	0.367	0.359	0.355	0.347	0.337	0.326	0.322	0.326	0.350	0.353
F2534/F1544	RATIO	0.323	0.334	0.346	0.360	0.376	0.390	0.399	0.406	0.408	0.401	0.388	0.374	0.358	0.345	0.337	0.323	0.327
F3544/F1544	RATIO	0.215	0.218	0.221	0.223	0.222	0.221	0.223	0.227	0.233	0.244	0.265	0.289	0.316	0.333	0.337	0.328	0.321
FAMILY SIZE	NUMBER	4.439	4.389	4.340	4.292	4.244	4.197	4.150	4.104	4.059	4.013	3.925	3.838	3.754	3.671	3.590	3.396	3.212
0 – 2	NUMBER	0.317	0.317	0.312	0.311	0.309	0.304	0.298	0.290	0.280	0.269	0.248	0.230	0.216	0.202	0.189	0.166	0.155
3 – 5	NUMBER	0.266	0.268	0.277	0.282	0.281	0.276	0.275	0.273	0.270	0.265	0.251	0.233	0.216	0.202	0.191	0.164	0.148
6 – 13	NUMBER	0.763	0.736	0.706	0.675	0.649	0.631	0.617	0.607	0.604	0.604	0.608	0.596	0.578	0.551	0.520	0.445	0.390
14 – 79	NUMBER	3.093	3.069	3.044	3.025	3.006	2.986	2.961	2.934	2.905	2.875	2.818	2.779	2.744	2.715	2.690	2.617	2.518
NO OF FAMILY	NUMBER	5 119	5 321	5 514	5 748	5 993	6 251	6 517	6 788	7 067	7 350	7 927	8 508	9 131	9 781	10 439	12 112	13 890
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	7 904	8 327	8 573	8 910	9 241	9 592	9 939	10 284	10 637	10 988	11 673	12 347	13 076	13 809	14 563	16 371	17 956
MALE	NUMBER	5 393	5 761	5 960	6 232	6 497	6 776	7 048	7 321	7 595	7 859	8 374	8 880	9 426	9 964	10 506	11 804	13 021
FEMALE	NUMBER	2 511	2 566	2 613	2 677	2 744	2 817	2 890	2 963	3 043	3 128	3 298	3 467	3 650	3 845	4 058	4 567	4 934
LABOUR FORCE	RATE	0.514	0.525	0.526	0.527	0.527	0.528	0.528	0.529	0.530	0.532	0.535	0.534	0.533	0.531	0.530	0.527	0.523
MALE	RATE	0.730	0.755	0.759	0.765	0.767	0.770	0.772	0.775	0.779	0.783	0.789	0.790	0.790	0.787	0.784	0.779	0.779
FEMALE	RATE	0.315	0.312	0.309	0.306	0.303	0.300	0.298	0.296	0.295	0.295	0.294	0.292	0.290	0.288	0.288	0.287	0.280
LF HIGH GRD	RATIO	0.335	0.341	0.349	0.355	0.361	0.367	0.373	0.379	0.385	0.392	0.404	0.416	0.427	0.438	0.449	0.480	0.513
MALE	RATIO	0.436	0.439	0.441	0.443	0.446	0.449	0.453	0.455	0.458	0.462	0.469	0.476	0.482	0.488	0.495	0.515	0.538
FEMALE	RATIO	0.258	0.267	0.277	0.286	0.295	0.303	0.311	0.319	0.328	0.337	0.355	0.371	0.385	0.399	0.414	0.456	0.498

Appendix table 10

Vital rates and composition (rural): basic prospect

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
FERTILITY																		
15 – 19	RATE	0.087	0.083	0.081	0.079	0.077	0.075	0.074	0.073	0.072	0.071	0.070	0.069	0.068	0.068	0.068	0.068	0.068
20 – 24	RATE	0.757	0.738	0.724	0.712	0.701	0.691	0.682	0.674	0.667	0.661	0.652	0.645	0.640	0.637	0.635	0.632	0.631
25 – 29	RATE	1.220	1.195	1.171	1.148	1.127	1.107	1.089	1.072	1.056	1.041	1.015	0.992	0.972	0.955	0.941	0.913	0.895
30 – 34	RATE	0.711	0.687	0.663	0.641	0.621	0.602	0.584	0.568	0.553	0.539	0.514	0.492	0.474	0.458	0.444	0.419	0.402
35 – 39	RATE	0.180	0.166	0.152	0.139	0.128	0.119	0.110	0.102	0.095	0.089	0.078	0.070	0.063	0.057	0.052	0.043	0.037
40 – 44	RATE	0.078	0.072	0.068	0.063	0.060	0.057	0.054	0.052	0.050	0.048	0.045	0.043	0.041	0.040	0.039	0.038	0.037
TFR	RATE	3.033	2.942	2.859	2.783	2.714	2.651	2.593	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
ACB	AGE	27.6	27.6	27.5	27.4	27.4	27.3	27.2	27.2	27.1	27.1	27.0	26.9	26.8	26.8	26.7	26.6	26.5
CBR	1/1000	19.2	19.2	18.7	18.6	18.7	- 18.7	18.8	18.9	19.1	19.2	19.4	19.0	18.3	17.2	15.7	12.4	11.2
MORTALITY																		
LIFE EXP (F)	YEAR	69.6	70.0	70.4	71.1	71.4	71.7	72.1	72.4	72.6	72.9	73.4	73.9	74.3	74.7	75.1	75.9	76.5
LIFE EXP (M)	YEAR	63.2	63.6	64.0	64.7	65.0	65.3	65.6	65.9	66.2	66.4	66.9	67.3	67.6	68.0	68.2	69.0	69.7
CDR	1/1000	8.1	8.1	8.1	7.9	7.9	7.9	7.9	8.0	8.0	8.1	8.3	8.5	8.7	9.1	9.5	10.7	12.1
GROWTH RATE	1/1000	10.0	9.9	9.5	9.6	9.7	9.7	9.8	9.8	9.9	10.0	10.0	9.4	8.5	7.0	5.1	0.7	–2.0
RNI	1/1000	11.1	11.0	10.6	10.7	10.8	10.8	10.9	10.9	11.0	11.1	11.1	10.5	9.6	8.1	6.2	1.8	–0.9
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
NRR	NUMBER	1.38	1.34	1.31	1.28	1.25	1.23	1.20	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
NET MIGRATION	RATE	0.028	0.012	0.008	0.016	0.017	0.019	0.019	0.020	0.021	0.021	0.021	0.020	0.026	0.027	0.026	0.025	0.027
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.681	0.696	0.712	0.730	0.746	0.784	0.819
SEX RATIO	RATIO	1.023	1.021	1.019	1.017	1.014	1.012	1.010	1.007	1.005	1.003	0.998	0.993	0.987	0.981	0.974	0.958	0.945
M2531/F2127	RATIO	0.893	0.938	1.007	1.079	1.113	1.102	1.085	1.057	1.019	0.987	0.962	1.023	1.115	1.202	1.274	1.199	1.060
DEPENDENCY	RATIO	0.687	0.662	0.635	0.610	0.589	0.572	0.557	0.547	0.539	0.537	0.539	0.547	0.560	0.576	0.592	0.602	0.565
YOUNG (14–)	RATIO	0.590	0.565	0.538	0.512	0.490	0.471	0.453	0.440	0.430	0.424	0.419	0.420	0.422	0.425	0.424	0.395	0.335
OLD (65+)	RATIO	0.097	0.098	0.098	0.098	0.099	0.101	0.104	0.107	0.110	0.113	0.120	0.127	0.137	0.151	0.168	0.208	0.230
F1544/FTOTAL	RATIO	0.402	0.407	0.414	0.420	0.424	0.427	0.429	0.431	0.433	0.433	0.429	0.423	0.416	0.408	0.399	0.382	0.367
F1524/F1544	RATIO	0.445	0.455	0.465	0.472	0.478	0.481	0.483	0.480	0.473	0.459	0.426	0.393	0.363	0.337	0.323	0.330	0.356
F2534/F1544	RATIO	0.278	0.279	0.279	0.281	0.284	0.288	0.292	0.297	0.303	0.311	0.330	0.350	0.365	0.371	0.362	0.297	0.253
F3544/F1544	RATIO	0.277	0.266	0.256	0.246	0.238	0.231	0.225	0.223	0.224	0.230	0.243	0.257	0.272	0.291	0.314	0.374	0.391
FAMILY SIZE	NUMBER	4.830	4.776	4.722	4.669	4.617	4.566	4.514	4.464	4.414	4.365	4.268	4.174	4.081	3.991	3.903	3.692	3.492
0 – 2	NUMBER	0.278	0.270	0.262	0.256	0.251	0.249	0.247	0.245	0.244	0.243	0.240	0.234	0.223	0.207	0.188	0.141	0.117
3 – 5	NUMBER	0.294	0.281	0.270	0.262	0.256	0.250	0.245	0.241	0.238	0.237	0.234	0.232	0.229	0.223	0.211	0.165	0.128
6 – 13	NUMBER	0.992	0.946	0.893	0.844	0.797	0.752	0.716	0.682	0.657	0.638	0.610	0.592	0.582	0.578	0.574	0.535	0.438
14 – 79	NUMBER	3.267	3.279	3.298	3.307	3.312	3.315	3.308	3.296	3.275	3.247	3.183	3.116	3.048	2.983	2.931	2.851	2.809
NO OF FAMILY	NUMBER	3 309	3 339	3 384	3 399	3 412	3 418	3 423	3 427	3 427	3 425	3 421	3 421	3 390	3 335	3 269	3 073	2 830
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	6 875	7 207	7 368	7 484	7 550	7 592	7 612	7 614	7 600	7 570	7 465	7 329	7 112	6 835	6 563	5 952	5 363
MALE	NUMBER	3 772	4 045	4 134	4 209	4 243	4 259	4 263	4 259	4 247	4 230	4 170	4 088	3 964	3 800	3 643	3 292	2 961
FEMALE	NUMBER	3 103	3 163	3 234	3 274	3 308	3 333	3 349	3 355	3 353	3 340	3 295	3 241	3 149	3 035	2 920	2 660	2 402
LABOUR FORCE	RATE	0.653	0.675	0.676	0.681	0.684	0.686	0.689	0.691	0.694	0.697	0.701	0.703	0.703	0.701	0.698	0.690	0.684
MALE	RATE	0.734	0.777	0.778	0.786	0.789	0.792	0.795	0.798	0.802	0.806	0.812	0.814	0.816	0.814	0.812	0.804	0.800
FEMALE	RATE	0.576	0.579	0.580	0.582	0.584	0.586	0.588	0.590	0.593	0.595	0.598	0.600	0.599	0.597	0.594	0.586	0.580
LF HIGH GRD	RATIO	0.109	0.116	0.123	0.130	0.138	0.146	0.154	0.162	0.171	0.179	0.195	0.210	0.223	0.235	0.246	0.276	0.306
MALE	RATIO	0.168	0.175	0.181	0.187	0.195	0.203	0.211	0.219	0.226	0.233	0.248	0.262	0.274	0.284	0.294	0.319	0.344
FEMALE	RATIO	0.050	0.055	0.062	0.069	0.077	0.085	0.093	0.102	0.111	0.119	0.136	0.152	0.167	0.181	0.194	0.229	0.265

Appendix table 11

Vital rates and composition (total): basic prospect

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
FERTILITY																		
15 – 19	RATE	0.076	0.074	0.073	0.073	0.072	0.071	0.070	0.069	0.068	0.068	0.067	0.067	0.067	0.067	0.067	0.067	0.066
20 – 24	RATE	0.688	0.678	0.671	0.666	0.661	0.657	0.653	0.649	0.646	0.642	0.636	0.633	0.630	0.629	0.628	0.627	0.628
25 – 29	RATE	1.119	1.097	1.079	1.062	1.046	1.030	1.017	1.004	0.993	0.984	0.968	0.953	0.938	0.925	0.914	0.895	0.883
30 – 34	RATE	0.619	0.598	0.580	0.563	0.546	0.532	0.518	0.506	0.495	0.485	0.466	0.452	0.441	0.431	0.421	0.403	0.392
35 – 39	RATE	0.135	0.123	0.113	0.104	0.096	0.090	0.084	0.078	0.073	0.069	0.062	0.056	0.051	0.047	0.044	0.038	0.034
40 – 44	RATE	0.063	0.059	0.055	0.052	0.050	0.048	0.046	0.045	0.043	0.042	0.041	0.039	0.038	0.038	0.037	0.037	0.036
TFR	RATE	2.699	2.630	2.571	2.519	2.471	2.427	2.388	2.352	2.319	2.290	2.240	2.199	2.164	2.135	2.111	2.087	2.041
ACB	AGE	27.4	27.4	27.3	27.2	27.1	27.1	27.0	27.0	26.9	26.9	26.8	26.8	26.7	26.7	26.6	26.5	26.5
CBR	1/1000	22.6	22.7	22.7	22.8	22.8	22.7	22.5	22.2	21.8	21.4	20.6	19.8	19.0	18.1	17.1	15.6	15.5
MORTALITY																		
LIFE EXP (F)	YEAR	69.6	70.0	70.4	71.1	71.4	71.7	72.1	72.4	72.6	72.9	73.4	73.9	74.3	74.7	75.1	75.9	76.5
LIFE EXP (M)	YEAR	63.2	63.6	64.0	64.7	65.0	65.3	65.6	65.9	66.2	66.4	66.9	67.3	67.6	68.0	68.2	69.0	69.7
CDP	1/1000	6.3	6.3	6.2	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.8	5.9	6.0	6.5	7.0
GROWTH RATE	1/1000	15.2	15.3	15.4	15.6	15.8	15.8	15.6	15.3	15.0	14.6	13.8	13.0	12.1	11.1	10.0	8.1	7.4
RNI	1/1000	16.3	16.4	16.5	16.7	16.9	16.9	16.7	16.4	16.1	15.7	14.9	14.1	13.2	12.2	11.1	9.2	8.5
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
NRR	NUMBER	1.23	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.05	1.03	1.02	1.01	1.00	0.98	0.97
NET MIGRATION	RATE	0.012	0.005	0.003	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.006	0.008	0.007	0.007	0.006	0.005
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.681	0.696	0.712	0.730	0.746	0.784	0.819
SEX RATIO	RATIO	1.017	1.016	1.015	1.014	1.013	1.012	1.011	1.010	1.009	1.008	1.006	1.004	1.002	1.000	0.999	0.994	0.989
N2531/F2127	RATIO	0.825	0.825	0.848	0.878	0.911	0.951	0.995	1.038	1.070	1.081	1.056	1.032	1.053	1.128	1.177	1.015	0.995
DEPENDENCY	RATIO	0.594	0.581	0.568	0.555	0.542	0.530	0.520	0.514	0.509	0.507	0.506	0.504	0.498	0.491	0.482	0.457	0.435
YOUNG (14–)	RATIO	0.532	0.519	0.506	0.493	0.479	0.467	0.457	0.449	0.443	0.439	0.436	0.432	0.423	0.412	0.398	0.359	0.328
OLD (65 +)	RATIO	0.062	0.062	0.062	0.062	0.062	0.063	0.064	0.065	0.066	0.067	0.069	0.072	0.075	0.079	0.085	0.098	0.107
F1544/FTOTAL	RATIO	0.482	0.484	0.486	0.488	0.491	0.493	0.494	0.495	0.496	0.496	0.493	0.490	0.489	0.488	0.484	0.470	0.452
F1524/F1544	RATIO	0.456	0.450	0.444	0.436	0.427	0.419	0.411	0.402	0.394	0.385	0.369	0.352	0.335	0.326	0.325	0.346	0.353
F2534/F1544	RATIO	0.307	0.315	0.323	0.334	0.345	0.357	0.365	0.372	0.376	0.375	0.372	0.368	0.360	0.351	0.342	0.318	0.316
F3544/F1544	RATIO	0.236	0.234	0.233	0.231	0.227	0.224	0.224	0.225	0.230	0.240	0.259	0.281	0.305	0.324	0.332	0.336	0.331
FAMILY SIZE	NUMBER	4.593	4.538	4.486	4.432	4.380	4.327	4.276	4.225	4.175	4.125	4.028	3.934	3.842	3.752	3.665	3.455	3.259
0 – 2	NUMBER	0.301	0.299	0.293	0.291	0.288	0.284	0.280	0.275	0.268	0.261	0.246	0.232	0.218	0.203	0.189	0.161	0.149
3 – 5	NUMBER	0.277	0.273	0.275	0.274	0.272	0.267	0.265	0.262	0.259	0.256	0.246	0.233	0.220	0.208	0.195	0.164	0.145
6 – 13	NUMBER	0.853	0.817	0.777	0.738	0.703	0.674	0.651	0.632	0.621	0.615	0.609	0.595	0.579	0.558	0.533	0.467	0.398
14 – 79	NUMBER	3.161	3.150	3.141	3.130	3.117	3.102	3.080	3.056	3.026	2.993	2.928	2.875	2.826	2.783	2.747	2.664	2.568
NO OF FAMILY	NUMBER	8 428	8 660	8 898	9 147	9 405	9 669	9 940	10 215	10 493	10 775	11 347	11.929	12 521	13 116	13 708	15 185	16.720
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	14 779	15 534	15 941	16 394	16 791	17 184	17 551	17 898	18 237	18 558	19 138	19 676	20 188	20 644	21 126	22 323	23 319
MALE	NUMBER	9 165	9 806	10 094	10 442	10 739	11 034	11 313	11 580	11 842	12 089	12 545	12 968	13 389	13 764	14 148	15 098	15 982
FEMALE	NUMBER	5 614	5 728	5 846	5 952	6 052	6 150	6 238	6 318	6 395	6 468	6 593	6 708	6 798	6 880	6 978	7 227	7 337
LABOUR FORCE	RATE	0.571	0.586	0.586	0.588	0.588	0.588	0.588	0.588	0.588	0.589	0.589	0.586	0.583	0.577	0.572	0.562	0.553
MALE	RATE	0.732	0.764	0.767	0.773	0.776	0.779	0.781	0.784	0.787	0.791	0.796	0.797	0.798	0.794	0.791	0.785	0.782
FEMALE	RATE	0.420	0.418	0.417	0.414	0.411	0.408	0.406	0.403	0.401	0.399	0.394	0.388	0.381	0.373	0.367	0.353	0.337
LF HIGH GRD	RATIO	0.241	0.251	0.259	0.268	0.276	0.285	0.293	0.302	0.310	0.319	0.337	0.353	0.368	0.383	0.398	0.436	0.475
MALE	RATIO	0.329	0.335	0.341	0.346	0.353	0.360	0.367	0.374	0.380	0.387	0.400	0.413	0.424	0.436	0.447	0.476	0.506
FEMALE	RATIO	0.161	0.171	0.181	0.191	0.201	0.210	0.220	0.230	0.240	0.251	0.273	0.293	0.311	0.329	0.348	0.397	0.444

Appendix table 12

Composition of GNP and employment: basic prospect

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
GNP IN 1975 BIL WON																	
CONSUMPTION PVT	10.0	10.7	11.5	12.3	13.1	14.1	15.0	16.1	17.2	18.4	21.0	24.0	27.4	31.4	36.0	51.3	74.6
CONSUMPTION GVT	1.5	1.6	1.8	1.9	2.0	2.1	2.3	2.5	2.6	2.8	3.2	3.7	4.2	4.8	5.5	7.8	11.4
INVESTMENT	4.6	5.0	5.4	5.8	6.2	6.7	7.1	7.7	8.2	8.9	10.2	11.8	13.6	15.7	18.2	26.6	39.7
EXPORT	6.8	7.1	7.5	7.9	8.3	8.8	9.3	9.8	10.3	10.9	12.3	13.8	15.6	17.7	20.2	28.7	42.2
IMPORT	8.2	8.6	9.1	9.6	10.1	10.6	11.1	11.7	12.3	12.9	14.3	15.9	17.7	19.8	22.3	30.2	42.3
VALUE ADDED TOTAL	14.7	15.8	16.9	18.2	19.6	21.0	22.6	24.3	26.1	28.0	32.3	37.3	43.0	49.8	57.7	84.2	125.7
AGRICULTURE	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.3	3.4	3.5	3.7	3.8	4.0	4.5	5.1
LIGHT MANU	2.5	2.7	2.9	3.1	3.4	3.7	3.9	4.2	4.6	4.9	5.7	6.6	7.7	8.9	10.4	15.3	23.0
HEAVY MANU	2.6	2.9	3.4	3.8	4.3	4.9	5.5	6.2	6.9	7.7	9.5	11.7	14.2	17.3	20.9	33.2	53.0
SOC OVERHEAD	2.1	2.3	2.5	2.7	3.0	3.2	3.5	3.8	4.1	4.4	5.1	6.0	7.0	8.1	9.5	14.1	21.4
OTHER SERVICES	4.8	5.1	5.3	5.6	5.9	6.3	6.6	7.0	7.3	7.7	8.5	9.5	10.5	11.7	13.0	17.1	23.2
EMPLOYMENT (1000 PERSONS)																	
URBAN	7 251	7 589	7 836	8 125	8 417	8 726	9 052	9 379	9 717	10 063	10 912	11 807	12 517	13 233	13 970	15 735	17 284
PRIMARY	326	337	339	339	337	335	331	328	324	319	312	305	291	277	263	229	194
SECONDARY	2 879	3 186	3 446	3 703	3 949	4 191	4 434	4 675	4 916	5 156	5 690	6 279	6 802	7 321	7 859	9 216	10 484
TERTIARY	4 046	4 066	4 051	4 083	4 131	4 200	4 287	4 376	4 477	4 589	4 910	5 223	5 423	5 634	5 847	6 290	6 606
RURAL	6 759	7 075	7 237	7 347	7 410	7 448	7 470	7 475	7 464	7 439	7 373	7 278	7 065	6 792	6 523	5 919	5 335
PRIMARY	5 107	5 280	5 313	5 313	5 283	5 241	5 192	5 133	5 069	4 998	4 887	4 771	4 567	4 344	4 125	3 580	3 037
SECONDARY	511	528	531	531	528	524	519	513	507	500	489	477	457	434	413	358	304
TERTIARY	1 141	1 266	1 393	1 502	1 599	1 684	1 759	1 828	1 888	1 941	1 997	2 030	2 042	2 013	1 985	1 980	1 995
TOTAL	14 010	14 664	15 073	15 471	15 827	16 175	16 523	16 853	17 181	17 503	18 285	19 086	19 582	20 025	20 492	21 653	22 619
PRIMARY	5 433	5 617	5 653	5 652	5 620	5 575	5 523	5 461	5 392	5 317	5 199	5 076	4 858	4 622	4 388	3 809	3 230
SECONDARY	3 390	3 714	3 977	4 234	4 477	4 715	4 953	5 189	5 423	5 655	6 178	6 756	7 259	7 756	8 271	9 574	10 788
TERTIARY	5 187	5 333	5 444	5 585	5 730	5 884	6 046	6 204	6 366	6 530	6 907	7 253	7 465	7 647	7 833	8 270	8 601
UNEMPLOYMENT RATE	0.052	0.056	0.054	0.056	0.057	0.059	0.059	0.058	0.058	0.057	0.045	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	0.083	0.089	0.086	0.088	0.089	0.090	0.089	0.088	0.087	0.084	0.065	0.044	0.043	0.042	0.041	0.039	0.037
RURAL	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.018	0.018	0.017	0.012	0.007	0.007	0.006	0.006	0.006	0.005
PER LABOUR GNP (MIL W)	1.05	1.08	1.12	1.18	1.24	1.30	1.37	1.44	1.52	1.60	1.77	1.95	2.20	2.49	2.82	3.89	5.56
PRIMARY	0.49	0.49	0.49	0.51	0.52	0.54	0.56	0.57	0.59	0.61	0.65	0.70	0.76	0.83	0.91	1.17	1.57
SECONDARY	1.49	1.52	1.58	1.65	1.73	1.82	1.91	2.01	2.12	2.23	2.46	2.71	3.02	3.37	3.78	5.06	7.05
TERTIARY	1.34	1.39	1.45	1.50	1.56	1.61	1.67	1.73	1.79	1.85	1.98	2.13	2.34	2.59	2.87	3.78	5.19
URBAN	1.36	1.40	1.46	1.53	1.60	1.67	1.75	1.83	1.92	2.01	2.19	2.40	2.67	2.99	3.34	4.50	6.27
RURAL	0.71	0.72	0.76	0.79	0.83	0.87	0.91	0.95	1.00	1.05	1.13	1.23	1.36	1.51	1.69	2.28	3.24
PC GNP (75 1000$)	0.78	0.83	0.88	0.93	0.98	1.04	1.10	1.16	1.23	1.30	1.46	1.64	1.85	2.09	2.37	3.32	4.77
GNP GROWTH RATE	0.054	0.075	0.075	0.075	0.075	0.075	0.074	0.074	0.074	0.074	0.074	0.074	0.075	0.076	0.077	0.080	0.086

Appendix table 13

Major indicators: basic prospect

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
POPULATION	1000	28 706	39 302	39 914	40 543	41 188	41 841	42 499	43 155	43 807	44 451	45 711	46 933	48 109	49 215	50 236	52 472	54 495
URBAN	1000	22 721	23 355	23 935	24 672	25 436	26 235	27 046	27 859	28 680	29 500	31 110	32 656	34 273	35 905	37 476	41 127	44 613
RURAL	1000	15 986	15 948	15 979	15 870	15 752	15 607	15 453	15 296	15 126	14 951	14 601	14 277	13 837	13 310	12 761	11 344	9 881
POP GROWTH	1/1000	15.2	15.3	15.4	15.6	15.8	15.8	15.6	15.3	15.0	14.6	13.8	13.0	12.1	11.1	10.0	8.1	7.4
URBAN	1/1000	19.0	19.0	19.4	19.7	19.7	19.5	19.0	18.5	17.7	17.0	15.6	14.6	13.7	12.7	11.7	10.2	9.5
RURAL	1/1000	10.0	9.9	9.5	9.6	9.7	9.7	9.8	9.8	9.9	10.0	10.0	9.4	8.5	7.0	5.1	0.7	−2.0
CBR	1/1000	22.6	22.7	22.7	22.8	22.8	22.7	22.5	22.2	21.8	21.4	20.6	19.8	19.0	18.1	17.1	15.6	15.5
URBAN	1/1000	25.2	25.1	25.5	25.6	25.4	25.2	24.7	24.1	23.4	22.6	21.2	20.2	19.3	18.4	17.6	16.6	16.5
RURAL	1/1000	19.2	19.2	18.7	18.6	18.7	18.7	18.8	18.9	19.1	19.2	19.4	19.0	18.3	17.2	15.7	12.4	11.2
CDR	1/1000	6.3	6.3	6.2	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.8	5.9	6.0	6.5	7.0
URBAN	1/1000	5.1	5.0	4.9	4.8	4.7	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.6	4.7	4.8	5.3	5.8
RURAL	1/1000	8.1	8.1	8.1	7.9	7.9	7.9	7.9	8.0	8.0	8.1	8.3	8.5	8.7	9.1	9.5	10.7	12.1
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
TFR	RATE	2.699	2.630	2.571	2.519	2.471	2.427	2.388	2.352	2.319	2.290	2.240	2.199	2.164	2.135	2.111	2.067	2.041
URBAN	RATE	2.530	2.483	2.440	2.401	2.366	2.334	2.304	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.036
RURAL	RATE	3.033	2.942	2.859	2.783	2.714	2.651	2.593	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.05	1.03	1.02	1.01	1.00	0.98	0.97
URBAN	1/1000	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.95	0.98	0.97
RURAL	1/1000	1.38	1.34	1.31	1.28	1.25	1.23	1.20	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.681	0.696	0.712	0.730	0.746	0.784	0.819
NET MIGRATION	RATE	0.012	0.005	0.003	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.006	0.008	0.007	0.007	0.006	0.005
URBAN	RATE	0.021	0.009	0.005	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.010	0.009	0.011	0.010	0.009	0.007	0.006
RURAL	RATE	0.028	0.012	0.008	0.016	0.017	0.019	0.019	0.020	0.021	0.021	0.021	0.020	0.026	0.027	0.026	0.025	0.027
DEPENDENCY	RATIO	0.594	0.581	0.568	0.555	0.542	0.530	0.520	0.514	0.509	0.507	0.506	0.504	0.498	0.491	0.482	0.457	0.435
URBAN	RATIO	0.534	0.530	0.527	0.521	0.514	0.507	0.500	0.497	0.494	0.492	0.490	0.486	0.474	0.462	0.449	0.421	0.409
RURAL	RATIO	0.687	0.662	0.635	0.610	0.589	0.572	0.557	0.547	0.539	0.537	0.539	0.547	0.560	0.576	0.592	0.602	0.565
F1544 TOTAL	RATIO	0.482	0.484	0.486	0.488	0.491	0.493	0.494	0.495	0.496	0.496	0.493	0.490	0.489	0.488	0.484	0.470	0.452
URBAN	RATIO	0.538	0.536	0.534	0.532	0.532	0.532	0.532	0.530	0.529	0.528	0.524	0.519	0.519	0.518	0.514	0.494	0.471
RURAL	RATIO	0.402	0.407	0.414	0.420	0.424	0.427	0.429	0.431	0.433	0.433	0.429	0.423	0.416	0.408	0.399	0.382	0.367
NO OF FAMILY	NUMBER	8 428	8 660	8 898	9 147	9 405	9 669	9 940	10 215	10 493	10 775	11 347	11 929	12 521	13 116	13 708	15 185	16 720
URBAN	NUMBER	5 119	5 321	5 514	5 748	5 993	6 251	6 517	6 788	7 067	7 350	7 927	8 508	9 131	9 781	10 439	12 112	13 890
RURAL	NUMBER	3 309	3 339	3 384	3 399	3 412	3 418	3 423	3 427	3 427	3 425	3 421	3 421	3 390	3 335	3 269	3 073	2 830
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	14 779	15 534	15 941	16 394	16 791	17 184	17 551	17 898	18 237	18 558	19 138	19 676	20 188	20 644	21 126	22 323	23 319
URBAN	NUMBER	7 904	8 327	8 573	8 910	9 241	9 592	9 939	10 284	10 637	10 988	11 673	12 347	13 076	13 809	14 563	16 371	17 956
RURAL	NUMBER	6 875	7 207	7 368	7 484	7 550	7 592	7 612	7 614	7 600	7 570	7 465	7 329	7 112	6 835	6 563	5 952	5 363
LABOUR FORCE	RATE	0.571	0.586	0.586	0.588	0.588	0.588	0.588	0.588	0.588	0.589	0.589	0.586	0.583	0.577	0.572	0.562	0.553
URBAN	RATE	0.514	0.525	0.526	0.527	0.527	0.528	0.528	0.529	0.530	0.532	0.535	0.534	0.533	0.531	0.530	0.527	0.523
RURAL	RATE	0.653	0.675	0.676	0.681	0.684	0.686	0.689	0.691	0.694	0.697	0.701	0.703	0.703	0.701	0.698	0.690	0.684
LF HIGH GRD	RATIO	0.241	0.251	0.259	0.268	0.276	0.285	0.293	0.302	0.310	0.319	0.337	0.353	0.368	0.383	0.398	0.436	0.475
URBAN	RATIO	0.335	0.341	0.349	0.355	0.361	0.367	0.373	0.379	0.385	0.392	0.404	0.416	0.427	0.438	0.449	0.480	0.513
RURAL	RATIO	0.109	0.116	0.123	0.130	0.138	0.146	0.154	0.162	0.171	0.179	0.195	0.210	0.223	0.235	0.246	0.278	0.306
UNEMPLOYMENT	RATE	0.052	0.056	0.054	0.056	0.057	0.059	0.059	0.058	0.058	0.057	0.045	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.089	0.086	0.088	0.089	0.090	0.089	0.088	0.087	0.084	0.065	0.044	0.043	0.042	0.041	0.039	0.037
RURAL	RATE	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.018	0.018	0.017	0.012	0.007	0.007	0.006	0.006	0.006	0.005
PER LABOUR GNP	MIL W	1.05	1.08	1.12	1.18	1.24	1.30	1.37	1.44	1.52	1.60	1.77	1.95	2.20	2.49	2.82	3.89	5.56
URBAN	MIL W	1.36	1.40	1.46	1.53	1.60	1.67	1.75	1.83	1.92	2.01	2.19	2.40	2.67	2.99	3.34	4.50	6.27
RURAL	MIL W	0.71	0.72	0.76	0.79	0.83	0.87	0.91	0.95	1.00	1.05	1.13	1.23	1.36	1.51	1.69	2.28	3.24
P C GNP	1000 $	0.78	0.83	0.88	0.93	0.98	1.04	1.10	1.16	1.23	1.30	1.46	1.64	1.85	2.09	2.37	3.32	4.77
GNP GROWTH	RATE	0.054	0.075	0.075	0.075	0.075	0.075	0.074	0.074	0.074	0.074	0.074	0.074	0.075	0.076	0.077	0.080	0.086

Appendix table 14

Major indicators: (assumption F–1)

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
POPULATION	1000	38 706	39 543	40 593	41 576	42 487	43 316	44 051	44 719	45 367	46 007	47 262	48 479	49 650	50 753	51 777	54 145	56 743
URBAN	1000	22 721	23 498	24 896	25 715	26 641	27 426	28 247	29 017	29 829	30 654	32 279	33 895	35 562	37 179	38 704	42 408	46 432
RURAL	1000	15 986	16 045	15 696	15 861	15 846	15 889	15 804	15 703	15 538	15 353	14 982	14 584	14 089	13 573	13 073	11 737	10 312
POP GROWTH	1/1000	15.2	21.4	26.2	23.9	21.7	19.3	16.8	15.1	14.4	14.0	13.3	12.5	11.7	10.7	9.8	8.8	9.5
URBAN	1/1000	19.0	26.1	31.8	28.8	26.4	23.5	20.5	18.2	17.1	16.3	15.0	14.0	13.1	12.2	11.4	10.9	11.7
RURAL	1/1000	10.0	14.6	18.0	16.2	13.9	12.3	10.5	9.5	9.4	9.6	9.6	9.3	8.3	6.8	5.1	1.7	0.1
CBR	1/1000	22.6	28.8	33.6	31.1	28.7	26.2	23.7	21.8	21.1	20.7	19.9	19.2	18.4	17.5	16.7	16.2	17.4
URBAN	1/1000	25.2	32.2	37.9	34.7	32.2	29.1	26.1	23.7	22.5	21.8	20.4	19.5	18.6	17.8	17.2	17.1	18.5
RURAL	1/1000	19.2	23.9	27.2	25.4	22.9	21.3	19.5	18.5	18.3	18.6	18.8	18.7	18.0	16.8	15.4	13.1	12.8
CDR	1/1000	6.3	6.3	6.3	6.1	5.9	5.8	5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.7	5.8	6.3	6.8
URBAN	1/1000	5.1	5.0	5.0	4.8	4.7	4.6	4.5	4.4	4.4	4.3	4.3	4.4	4.4	4.5	4.7	5.1	5.7
RURAL	1/1000	8.1	8.2	8.1	8.1	7.9	7.9	7.8	7.8	7.9	7.9	8.1	8.3	8.5	8.9	9.2	10.4	11.7
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
TFR	RATE	2.699	4.072	3.743	3.416	3.098	2.785	2.476	2.350	2.319	2.290	2.240	2.199	2.164	2.135	2.111	2.067	2.041
URBAN	RATE	2.530	3.920	3.608	3.300	2.995	2.693	2.394	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.036
RURAL	RATE	3.033	4.380	4.027	3.681	3.343	3.010	2.683	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.86	1.71	1.57	1.43	1.29	1.15	1.09	1.08	1.07	1.05	1.03	1.02	1.01	1.00	0.98	0.97
URBAN	1/1000	1.15	1.79	1.65	1.52	1.38	1.25	1.11	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.99	0.98	0.97
RURAL	1/1000	1.38	1.99	1.84	1.69	1.54	1.39	1.24	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.594	0.613	0.619	0.627	0.633	0.641	0.649	0.658	0.666	0.683	0.699	0.716	0.733	0.748	0.783	0.818
NET MIGRATION	RATE	0.012	0.004	0.016	0.002	0.006	0.004	0.006	0.006	0.007	0.007	0.007	0.008	0.008	0.007	0.006	0.005	0.005
URBAN	RATE	0.021	0.008	0.026	0.004	0.009	0.006	0.009	0.009	0.011	0.011	0.010	0.011	0.011	0.009	0.008	0.007	0.006
RURAL	RATE	0.028	0.011	0.039	0.006	0.015	0.010	0.016	0.016	0.020	0.021	0.021	0.024	0.026	0.025	0.024	0.024	0.028
DEPENDENCY	RATIO	0.594	0.591	0.595	0.594	0.590	0.584	0.576	0.569	0.563	0.560	0.557	0.554	0.546	0.508	0.473	0.442	0.437
URBAN	RATIO	0.534	0.542	0.552	0.562	0.566	0.566	0.562	0.558	0.554	0.550	0.546	0.539	0.524	0.479	0.440	0.407	0.411
RURAL	RATIO	0.687	0.669	0.669	0.649	0.634	0.617	0.602	0.590	0.582	0.578	0.580	0.590	0.603	0.591	0.580	0.584	0.583
F1544/FTOTAL	RATIO	0.482	0.481	0.478	0.476	0.476	0.476	0.477	0.478	0.479	0.480	0.477	0.474	0.475	0.486	0.494	0.483	0.480
URBAN	RATIO	0.538	0.532	0.526	0.520	0.516	0.513	0.511	0.510	0.509	0.509	0.505	0.502	0.503	0.515	0.523	0.507	0.479
RURAL	RATIO	0.402	0.406	0.401	0.407	0.410	0.414	0.417	0.419	0.422	0.422	0.418	0.411	0.404	0.407	0.410	0.396	0.378
NO OF FAMILY	NUMBER	8 428	8 690	9 040	9 371	9 696	10 007	10 304	10 588	10 870	11 155	11 735	12 325	12 926	13 529	14 131	15 669	17 409
URBAN	NUMBER	5 119	5 339	5 723	5 980	6 268	6 529	6 804	7 070	7 350	7 638	8 224	8 831	9 474	10 128	10 781	12 489	14 456
RURAL	NUMBER	3 309	3 352	3 317	3 391	3 428	3 478	3 500	3 518	3 520	3 517	3 510	3 494	3 452	3 401	3 349	3 179	2 953
HIGH S ENROL	RATIO	0.705	0.721	0.737	0.752	0.765	0.779	0.793	0.808	0.824	0.839	0.863	0.878	0.880	0.884	0.894	0.935	0.955
LABOUR FORCE	NUMBER	14 779	14 172	14 963	15 480	16 180	16 796	17 440	17 868	18 224	18 550	19 129	19 685	20 209	20 929	21 622	23 233	24 302
URBAN	NUMBER	7 904	7 763	8 379	8 673	9 119	9 495	9 934	10 284	10 639	10 991	11 679	12 393	13 150	14 059	14 937	17 044	18 697
RURAL	NUMBER	6 875	6 410	6 583	6 806	7 061	7 300	7 506	7 584	7 586	7 559	7 450	7 292	7 059	6 870	6 685	6 188	5 605
LABOUR FORCE	RATE	0.571	0.534	0.550	0.555	0.566	0.574	0.584	0.587	0.588	0.589	0.589	0.587	0.580	0.569	0.564	0.583	0.556
URBAN	RATE	0.514	0.490	0.502	0.506	0.514	0.519	0.526	0.529	0.531	0.532	0.535	0.535	0.531	0.524	0.521	0.528	0.526
RURAL	RATE	0.653	0.599	0.626	0.634	0.652	0.666	0.683	0.689	0.693	0.696	0.701	0.703	0.700	0.692	0.689	0.691	0.690
LF HIGH GRD	RATIO	0.241	0.249	0.258	0.267	0.275	0.284	0.293	0.302	0.310	0.319	0.337	0.353	0.368	0.383	0.398	0.442	0.481
URBAN	RATIO	0.335	0.340	0.344	0.352	0.358	0.365	0.372	0.378	0.385	0.391	0.404	0.416	0.427	0.437	0.449	0.486	0.518
RURAL	RATIO	0.109	0.115	0.120	0.128	0.136	0.144	0.153	0.162	0.170	0.179	0.195	0.210	0.223	0.235	0.247	0.282	0.313
UNEMPLOYMENT	RATE	0.052	0.030	0.030	0.030	0.030	0.036	0.043	0.045	0.045	0.044	0.032	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.048	0.047	0.047	0.047	0.056	0.066	0.068	0.068	0.066	0.047	0.044	0.043	0.042	0.041	0.039	0.037
RURAL	RATE	0.017	0.008	0.008	0.008	0.008	0.010	0.013	0.013	0.013	0.013	0.008	0.007	0.007	0.006	0.006	0.006	0.005
PER LABOUR GNP	MIL W	1.05	1.15	1.18	1.24	1.28	1.34	1.39	1.46	1.54	1.62	1.79	2.00	2.26	2.53	2.84	3.86	5.55
URBAN	MIL W	1.36	1.50	1.54	1.60	1.65	1.71	1.78	1.86	1.95	2.04	2.22	2.46	2.74	3.04	3.37	4.46	6.26
RURAL	MIL W	0.71	0.74	0.75	0.79	0.82	0.87	0.91	0.96	1.01	1.05	1.14	1.25	1.39	1.53	1.70	2.26	3.23
P C GNP	1000 $	0.78	0.83	0.87	0.92	0.98	1.03	1.09	1.16	1.22	1.29	1.45	1.63	1.84	2.09	2.38	3.32	4.76
GNP GROWTH	RATE	0.054	0.079	0.084	0.082	0.080	0.078	0.076	0.074	0.074	0.073	0.073	0.074	0.076	0.077	0.077	0.081	0.088

Appendix table 15

Major indicators: (assumption F–2)

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
POPULATION	1000	38 706	39 543	40 623	41 700	42 770	43 826	44 859	45 866	46 839	47 775	49 522	50 837	51 998	53 092	54 110	56 495	59 382
URBAN	1000	22 721	23 498	24 915	25 897	27 016	28 058	29 132	30 185	31 237	32 269	34 280	35 859	37 538	39 172	40 697	44 353	48 567
RURAL	1000	15 986	16 045	15 708	15 804	15 754	15 767	15 727	15 680	15 602	15 506	15 242	14 977	14 460	13 921	13 413	12 142	10 815
POP GROWTH	1/1000	15.2	21.4	26.9	26.2	25.3	24.4	23.3	22.2	21.0	19.8	17.4	11.8	11.1	10.2	9.3	8.7	10.8
URBAN	1/1000	19.0	26.1	32.6	31.3	30.5	29.0	27.6	25.9	24.2	22.5	19.4	13.3	12.5	11.6	10.8	10.6	12.9
RURAL	1/1000	10.0	14.6	18.6	18.0	16.8	16.3	15.7	15.2	14.7	14.2	12.9	8.3	7.7	6.3	4.8	2.0	1.9
CBR	1/1000	22.6	28.8	34.3	33.3	32.3	31.3	30.1	28.9	27.7	26.4	23.9	18.3	17.6	16.8	16.0	15.8	18.5
URBAN	1/1000	25.2	32.2	38.8	37.2	36.3	34.7	33.2	31.5	29.7	27.9	24.7	18.6	17.8	17.0	16.4	16.6	19.5
RURAL	1/1000	19.2	23.9	27.8	27.2	25.9	25.4	24.7	24.2	23.7	23.2	22.0	17.5	17.1	16.1	14.9	13.1	14.2
CDR	1/1000	6.3	6.3	6.3	6.1	5.9	5.8	5.7	5.6	5.6	5.5	5.4	5.4	5.4	5.5	5.6	6.1	6.5
URBAN	1/1000	5.1	5.0	5.0	4.8	4.7	4.6	4.5	4.4	4.4	4.3	4.2	4.2	4.2	4.3	4.5	4.9	5.4
RURAL	1/1000	8.1	8.2	8.1	8.1	7.9	7.9	7.9	7.9	7.9	7.9	8.0	8.1	8.3	8.6	9.0	10.0	11.1
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
TFR	RATE	2.699	4.072	3.923	3.776	3.638	3.504	3.374	3.247	3.125	3.006	2.776	2.197	2.163	2.135	2.111	2.067	2.041
URBAN	RATE	2.530	3.920	3.788	3.659	3.534	3.412	3.292	3.176	3.061	2.949	2.730	2.159	2.132	2.110	2.091	2.057	2.036
RURAL	RATE	3.033	4.380	4.206	4.041	3.882	3.729	3.581	3.439	3.301	3.168	2.912	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.86	1.79	1.74	1.68	1.62	1.56	1.51	1.45	1.40	1.30	1.03	1.02	1.01	1.00	0.98	0.97
URBAN	1/1000	1.15	1.79	1.73	1.68	1.63	1.58	1.53	1.47	1.42	1.37	1.28	1.01	1.00	1.00	0.99	0.98	0.97
RURAL	1/1000	1.38	1.99	1.92	1.86	1.79	1.72	1.66	1.60	1.54	1.48	1.36	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.594	0.613	0.621	0.632	0.640	0.649	0.658	0.667	0.675	0.692	0.705	0.722	0.738	0.752	0.785	0.818
NET MIGRATION	RATE	0.012	0.004	0.016	0.005	0.007	0.006	0.006	0.006	0.007	0.007	0.007	0.004	0.007	0.007	0.006	0.005	0.005
URBAN	RATE	0.021	0.008	0.026	0.007	0.012	0.009	0.010	0.010	0.010	0.010	0.010	0.005	0.009	0.009	0.008	0.006	0.006
RURAL	RATE	0.028	0.011	0.039	0.012	0.020	0.015	0.018	0.018	0.020	0.020	0.022	0.013	0.024	0.024	0.023	0.022	0.027
DEPENDENCY	RATIO	0.594	0.591	0.596	0.599	0.601	0.603	0.605	0.609	0.614	0.619	0.631	0.629	0.619	0.576	0.527	0.439	0.421
URBAN	RATIO	0.534	0.542	0.553	0.566	0.576	0.584	0.590	0.599	0.606	0.612	0.623	0.618	0.600	0.550	0.496	0.405	0.396
RURAL	RATIO	0.687	0.669	0.669	0.656	0.647	0.639	0.633	0.631	0.631	0.635	0.650	0.657	0.670	0.654	0.631	0.575	0.544
F1544 TTOTAL	RATIO	0.482	0.481	0.478	0.475	0.473	0.471	0.469	0.466	0.465	0.462	0.456	0.453	0.454	0.466	0.478	0.493	0.478
URBAN	RATIO	0.538	0.532	0.526	0.518	0.513	0.508	0.503	0.498	0.494	0.491	0.482	0.478	0.480	0.493	0.505	0.518	0.496
RURAL	RATIO	0.402	0.406	0.401	0.404	0.405	0.406	0.406	0.405	0.406	0.404	0.398	0.393	0.387	0.391	0.398	0.409	0.398
NO OF FAMILY	NUMBER	8 428	8 690	9 044	9 396	9 755	10 117	10 481	10 847	11 211	11 574	12 289	12 931	13 543	14 159	14 773	16 351	18 218
URBAN	NUMBER	5 119	5 339	5 725	6 019	6 350	6 670	7 004	7 340	7 683	8 027	8 723	9 343	10 001	10 671	11 336	13 062	15 121
RURAL	NUMBER	3 309	3 352	3 319	3 377	3 405	3 446	3 477	3 506	3 529	3 547	3 567	3 588	3 543	3 488	3 436	3 289	3 097
HIGH S ENROL	RATIO	0.705	0.721	0.737	0.752	0.765	0.778	0.792	0.808	0.823	0.838	0.862	0.878	0.879	0.880	0.885	0.922	0.955
LABOUR FORCE	NUMBER	14 779	14 172	14 776	15 138	15 650	16 095	16 556	16 989	17 420	17 831	18 598	19 577	20 161	20 918	21 727	23 970	25 817
URBAN	NUMBER	7 904	7 763	8 299	8 571	8 972	9 320	9 697	10 065	10 445	10 823	11 591	12 430	13 219	14 149	15 103	17 834	19 722
RURAL	NUMBER	6 875	6 410	6 477	6 567	6 679	6 775	6 860	6 925	6 975	7 008	7 008	7 147	6 942	6 768	6 624	6 336	5 895
LABOUR FORCE	RATE	0.571	0.534	0.543	0.543	0.548	0.550	0.554	0.558	0.562	0.566	0.573	0.584	0.578	0.567	0.559	0.555	0.557
URBAN	RATE	0.514	0.490	0.498	0.498	0.502	0.504	0.508	0.511	0.514	0.518	0.525	0.533	0.531	0.523	0.518	0.520	0.527
RURAL	RATE	0.653	0.599	0.615	0.616	0.625	0.630	0.638	0.644	0.652	0.660	0.674	0.699	0.697	0.689	0.683	0.681	0.691
LF HIGH GRD	RATIO	0.241	0.249	0.257	0.266	0.274	0.283	0.292	0.300	0.309	0.318	0.336	0.353	0.368	0.383	0.398	0.444	0.488
URBAN	RATIO	0.335	0.340	0.344	0.351	0.357	0.363	0.369	0.375	0.382	0.389	0.402	0.415	0.426	0.436	0.448	0.487	0.525
RURAL	RATIO	0.109	0.115	0.120	0.127	0.134	0.142	0.150	0.158	0.167	0.175	0.192	0.209	0.222	0.234	0.247	0.284	0.322
UNEMPLOYMENT	RATE	0.052	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.048	0.047	0.047	0.047	0.046	0.046	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.041	0.039	0.037
RURAL	RATE	0.017	0.008	0.008	0.008	0.008	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.006	0.006	0.006	0.005
PER LABOUR GNP	MIL W	1.05	1.15	1.20	1.27	1.33	1.40	1.47	1.55	1.63	1.72	1.91	2.10	2.35	2.63	2.94	3.91	5.51
URBAN	MIL W	1.36	1.50	1.56	1.64	1.71	1.79	1.87	1.96	2.05	2.15	2.37	2.57	2.85	3.15	3.48	4.51	6.22
RURAL	MIL W	0.71	0.74	0.75	0.80	0.84	0.88	0.92	0.97	1.02	1.07	1.18	1.30	1.43	1.57	1.74	2.28	3.21
P C GNP	1000 $	0.78	0.83	0.87	0.92	0.97	1.03	1.09	1.15	1.21	1.28	1.44	1.62	1.83	2.07	2.36	3.32	4.76
GNP GROWTH	RATE	0.054	0.079	0.085	0.084	0.083	0.082	0.081	0.080	0.079	0.078	0.077	0.074	0.075	0.077	0.078	0.082	0.089

Appendix table 16

Major indicators: (assumption E–1)

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
POPULATION	1000	38 706	39 346	40 000	40 674	41 365	42 066	42 773	43 480	44 184	44 881	46 252	47 591	48 889	50 120	51 271	53 842	56 217
URBAN	1000	22 721	23 380	23 986	24 752	25 545	26 375	27 219	28 067	28 925	29 784	31 477	33 112	34 823	36 559	38 241	42 195	46 016
RURAL	1000	15 986	15 965	16 014	15 922	15 820	15 692	15 554	15 413	15 258	15 097	14 776	14 480	14 066	13 561	13 030	11 647	10 199
POP GROWTH	1/1000	15.2	16.4	16.5	16.7	16.8	16.8	16.7	16.4	16.1	15.7	14.9	14.1	13.2	12.2	11.1	9.1	8.4
URBAN	1/1000	19.0	20.1	20.5	20.7	20.7	20.5	20.1	19.5	18.8	18.1	16.7	15.7	14.7	13.7	12.8	11.3	10.6
RURAL	1/1000	10.0	11.0	10.6	10.6	10.8	10.8	10.8	10.9	11.0	11.1	11.0	10.5	9.6	8.1	6.2	1.8	–0.9
CBR	1/1000	22.6	22.7	22.7	22.8	22.8	22.7	22.5	22.2	21.8	21.4	20.6	19.8	19.0	18.1	17.1	15.6	15.5
URBAN	1/1000	25.2	25.1	25.4	25.5	25.4	25.2	24.7	24.1	23.3	22.6	21.2	20.2	19.3	18.4	17.6	16.6	16.5
RURAL	1/1000	19.2	19.2	18.7	18.6	18.7	18.7	18.8	18.9	19.1	19.2	19.4	19.0	18.3	17.2	15.7	12.4	11.2
CDR	1/1000	6.3	6.3	6.2	6.1	5.9	5.9	5.9	5.8	5.8	5.8	5.7	5.8	5.8	5.9	6.0	6.5	7.0
URBAN	1/1000	5.1	5.0	4.9	4.8	4.7	4.6	4.6	4.6	4.5	4.5	4.5	4.5	4.6	4.7	4.8	5.3	5.9
RURAL	1/1000	8.1	8.1	8.1	7.9	7.9	7.9	8.0	8.0	8.1	8.1	8.3	8.5	8.8	9.1	9.5	10.7	12.1
EMIGRATION	1/1000	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TFR	RATE	2.699	2.630	2.571	2.519	2.471	2.427	2.388	2.352	2.319	2.290	2.240	2.199	2.164	2.135	2.111	2.067	2.041
URBAN	RATE	2.530	2.483	2.440	2.401	2.366	2.334	2.304	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.036
RURAL	RATE	3.033	2.942	2.859	2.783	2.714	2.651	2.593	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.05	1.03	1.02	1.01	1.00	0.98	0.97
URBAN	1/1000	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.99	0.98	0.97
RURAL	1/1000	1.38	1.34	1.31	1.28	1.25	1.23	1.20	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.681	0.696	0.712	0.729	0.746	0.784	0.819
NET MIGRATION	RATE	0.012	0.005	0.003	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.006	0.008	0.007	0.007	0.006	0.005
URBAN	RATE	0.021	0.009	0.005	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.010	0.009	0.011	0.010	0.009	0.007	0.006
RURAL	RATE	0.028	0.012	0.008	0.016	0.017	0.019	0.019	0.020	0.021	0.021	0.021	0.020	0.026	0.027	0.026	0.025	0.027
DEPENDENCY	RATIO	0.594	0.581	0.568	0.555	0.542	0.530	0.520	0.514	0.509	0.506	0.505	0.503	0.497	0.491	0.482	0.456	0.434
URBAN	RATIO	0.534	0.530	0.527	0.521	0.514	0.507	0.500	0.497	0.494	0.492	0.490	0.485	0.474	0.461	0.448	0.421	0.408
RURAL	RATIO	0.687	0.662	0.635	0.610	0.589	0.572	0.557	0.547	0.539	0.536	0.539	0.547	0.559	0.576	0.591	0.602	0.564
F1544/FTOTAL	RATIO	0.482	0.484	0.486	0.488	0.491	0.493	0.495	0.495	0.496	0.496	0.493	0.490	0.490	0.488	0.485	0.470	0.452
URBAN	RATIO	0.538	0.536	0.534	0.532	0.532	0.532	0.532	0.530	0.529	0.529	0.524	0.519	0.520	0.518	0.514	0.494	0.471
RURAL	RATIO	0.402	0.407	0.414	0.420	0.424	0.427	0.429	0.431	0.433	0.433	0.429	0.423	0.416	0.408	0.400	0.382	0.367
NO OF FAMILY	NUMBER	8 428	8 669	8 917	9 177	9 445	9 721	10 004	10 291	10 584	10 880	11 482	12 096	12 724	13 357	13 990	15 581	17 248
URBAN	NUMBER	5 119	5 327	5 526	5 767	6 019	6 284	6 558	6 839	7 127	7 421	8 020	8 627	9 277	9 959	10 652	12 426	14 327
RURAL	NUMBER	3 309	3 343	3 391	3 410	3 426	3 437	3 445	3 453	3 457	3 459	3 462	3 469	3 446	3 398	3 338	3 155	2 921
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	14 779	15 552	15 977	16 450	16 868	17 282	17 672	18 041	18 404	18 749	19 378	19 968	20 534	21 045	21 584	22 931	24 083
URBAN	NUMBER	7 904	8 336	8 592	8 940	9 283	9 647	10 007	10 366	10 734	11 100	11 819	12 530	13 298	14 074	14 876	16 814	18 543
RURAL	NUMBER	6 875	7 216	7 385	7 509	7 585	7 635	7 664	7 675	7 670	7 649	7 560	7 438	7 237	6 971	6 708	6 116	5 541
LABOUR FORCE	RATE	0.571	0.586	0.586	0.588	0.588	0.588	0.588	0.588	0.588	0.589	0.589	0.587	0.583	0.577	0.573	0.562	0.553
URBAN	RATE	0.514	0.525	0.526	0.527	0.527	0.528	0.528	0.529	0.531	0.532	0.535	0.534	0.533	0.531	0.530	0.527	0.523
RURAL	RATE	0.653	0.675	0.676	0.681	0.684	0.686	0.689	0.691	0.694	0.697	0.701	0.703	0.703	0.701	0.698	0.690	0.684
LF HIGH GRD	RATIO	0.241	0.251	0.259	0.268	0.276	0.285	0.293	0.302	0.310	0.319	0.337	0.353	0.368	0.383	0.398	0.436	0.475
URBAN	RATIO	0.335	0.341	0.349	0.355	0.361	0.367	0.373	0.379	0.385	0.392	0.404	0.416	0.427	0.438	0.449	0.480	0.513
RURAL	RATIO	0.109	0.116	0.123	0.130	0.138	0.146	0.154	0.162	0.171	0.179	0.195	0.210	0.223	0.235	0.247	0.276	0.306
UNEMPLOYMENT	RATE	0.052	0.056	0.054	0.056	0.058	0.059	0.059	0.059	0.058	0.057	0.045	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.089	0.086	0.088	0.089	0.091	0.089	0.088	0.087	0.085	0.066	0.044	0.043	0.042	0.041	0.039	0.037
RURAL	RATE	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.018	0.018	0.017	0.013	0.007	0.007	0.006	0.006	0.006	0.005
PER LABOUR GNP	MIL W	1.05	1.08	1.12	1.18	1.24	1.30	1.37	1.44	1.52	1.60	1.77	1.95	2.20	2.48	2.81	3.89	5.55
URBAN	MIL W	1.36	1.40	1.46	1.53	1.59	1.67	1.75	1.83	1.92	2.01	2.19	2.40	2.67	2.98	3.34	4.49	6.27
RURAL	MIL W	0.71	0.72	0.76	0.79	0.83	0.87	0.91	0.95	1.00	1.05	1.13	1.23	1.36	1.51	1.69	2.28	3.23
P C GNP	1000 $	0.78	0.83	0.88	0.93	0.98	1.04	1.10	1.16	1.23	1.30	1.46	1.64	1.85	2.09	2.37	3.32	4.77
GNP GROWTH	RATE	0.054	0.076	0.076	0.076	0.076	0.076	0.076	0.075	0.075	0.075	0.075	0.076	0.076	0.077	0.078	0.081	0.087

Appendix table 17

Major indicators: (assumption E–2)

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
POPULATION	1000	38,706	39 302	39 914	40 543	41 188	41 841	42 499	43 155	43 807	44 451	45 761	47 085	48 369	49 587	50 724	53 268	55 621
URBAN	1000	22,721	23 355	23 935	24 672	25 436	26 235	27 046	27 859	28 680	29 500	31 144	32 762	34 456	36 174	37 837	41 747	45 531
RURAL	1000	15,986	15 948	15 979	15 870	15 752	15 607	15 453	15 296	15 126	14 951	14 617	14 324	13 913	13 413	12 888	11 520	10 090
POP GROWTH	1/1000	15.2	15.3	15.4	15.6	15.8	15.8	15.6	15.3	15.0	14.6	14.9	14.1	13.2	12.2	11.1	9.1	8.5
URBAN	1/1000	19.0	19.0	19.4	19.7	19.7	19.5	19.0	18.5	17.7	17.0	16.7	15.7	14.7	13.7	12.8	11.3	10.8
RURAL	1/1000	10.0	9.9	9.5	9.6	9.7	9.7	9.8	9.8	9.9	10.0	11.1	10.5	9.6	8.1	6.2	1.6	–0.9
CBR	1/1000	22.6	22.7	22.7	22.8	22.8	22.7	22.5	22.2	21.8	21.4	20.6	19.8	19.0	18.1	17.1	15.6	15.5
URBAN	1/1000	25.2	25.1	25.5	25.6	25.4	25.2	24.7	24.1	23.4	22.6	21.2	20.2	19.3	18.4	17.6	16.8	16.5
RURAL	1/1000	19.2	19.2	18.7	18.6	18.7	18.7	18.8	18.9	19.1	19.2	19.4	19.0	18.3	17.2	15.6	12.4	11.2
CDR	1/1000	6.3	6.3	6.2	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.8	5.8	5.9	6.0	6.5	7.0
URBAN	1/1000	5.1	5.0	4.9	4.8	4.7	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.6	4.7	4.8	5.3	5.9
RURAL	1/1000	8.1	8.1	8.1	7.9	7.9	7.9	7.9	8.0	8.0	8.1	8.3	8.5	8.7	9.1	9.5	10.7	12.1
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TFR	RATE	2.699	2.630	2.571	2.519	2.471	2.427	2.388	2.352	2.319	2.290	2.240	2.199	2.164	2.135	2.111	2.067	2.041
URBAN	RATE	2.530	2.483	2.440	2.401	2.366	2.334	2.304	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.038
RURAL	RATE	3.033	2.942	2.859	2.783	2.714	2.651	2.593	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.05	1.03	1.02	1.01	1.00	0.98	0.97
URBAN	1/1000	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.99	0.98	0.97
RURAL	1/1000	1.38	1.34	1.31	1.28	1.25	1.23	1.20	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.681	0.696	0.712	0.730	0.746	0.784	0.819
NET MIGRATION	RATE	0.012	0.005	0.003	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.006	0.008	0.007	0.007	0.006	0.005
URBAN	RATE	0.021	0.009	0.005	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.010	0.009	0.011	0.010	0.009	0.007	0.006
RURAL	RATE	0.028	0.012	0.008	0.016	0.017	0.019	0.019	0.020	0.021	0.021	0.021	0.020	0.026	0.027	0.026	0.025	0.027
DEPENDENCY	RATIO	0.594	0.581	0.568	0.555	0.542	0.530	0.520	0.514	0.509	0.507	0.506	0.504	0.498	0.491	0.482	0.456	0.434
URBAN	RATIO	0.534	0.530	0.527	0.521	0.514	0.507	0.500	0.497	0.494	0.492	0.490	0.486	0.474	0.462	0.448	0.421	0.408
RURAL	RATIO	0.687	0.662	0.635	0.610	0.589	0.572	0.557	0.547	0.539	0.537	0.539	0.547	0.559	0.576	0.591	0.801	0.564
F1544 FTOTAL	RATIO	0.482	0.484	0.486	0.488	0.491	0.493	0.494	0.495	0.496	0.496	0.493	0.490	0.489	0.488	0.484	0.470	0.452
URBAN	RATIO	0.538	0.536	0.534	0.532	0.532	0.532	0.532	0.530	0.529	0.528	0.524	0.519	0.519	0.518	0.514	0.494	0.471
RURAL	RATIO	0.402	0.407	0.414	0.420	0.424	0.427	0.429	0.431	0.433	0.433	0.429	0.423	0.416	0.408	0.395	0.383	0.367
NO OF FAMILY	NUMBER	8 428	8 660	8 898	9 147	9 405	9 669	9 940	10 215	10 493	10 775	11 360	11 968	12 588	13 215	13 841	15 415	17 065
URBAN	NUMBER	5 119	5 321	5 514	5 748	5 993	6 251	6 517	6 788	7 067	7 350	7 935	8 536	9 180	9 854	10 540	12 295	14 176
RURAL	NUMBER	3 309	3 339	3 384	3 399	3 412	3 418	3 423	3 427	3 427	3 425	3 425	3 432	3 409	3 361	3 302	3 121	2 890
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	14 779	15 534	15 941	16 394	16 791	17 184	17 551	17 898	18 237	18 558	19 159	19 743	20 303	20 809	21 343	22 679	23 822
URBAN	NUMBER	7 904	8 327	8 573	8 910	9 241	9 592	9 939	10 284	10 637	10 988	11 686	12 389	13 149	13 918	14 711	18 831	18 342
RURAL	NUMBER	6 875	7 207	7 368	7 484	7 550	7 592	7 612	7 614	7 600	7 570	7 474	7 354	7 153	6 891	6 631	6 048	5 480
LABOUR FORCE	RATE	0.571	0.586	0.586	0.588	0.588	0.588	0.588	0.588	0.588	0.589	0.589	0.586	0.583	0.577	0.572	0.562	0.553
URBAN	RATE	0.514	0.525	0.526	0.527	0.527	0.528	0.528	0.529	0.530	0.532	0.535	0.534	0.533	0.531	0.530	0.527	0.523
RURAL	RATE	0.653	0.675	0.676	0.681	0.684	0.686	0.689	0.691	0.694	0.697	0.701	0.703	0.703	0.701	0.698	0.690	0.884
LF HIGH GRD	RATIO	0.241	0.251	0.259	0.268	0.276	0.285	0.293	0.302	0.310	0.319	0.337	0.353	0.368	0.383	0.398	0.436	0.475
URBAN	RATIO	0.335	0.341	0.349	0.355	0.361	0.367	0.373	0.379	0.385	0.392	0.404	0.416	0.427	0.438	0.449	0.480	0.515
RURAL	RATIO	0.109	0.116	0.123	0.130	0.138	0.146	0.154	0.162	0.171	0.179	0.195	0.210	0.223	0.235	0.247	0.278	0.306
UNEMPLOYMENT	RATE	0.052	0.056	0.054	0.056	0.057	0.059	0.059	0.058	0.058	0.057	0.045	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.089	0.086	0.088	0.089	0.090	0.089	0.088	0.087	0.084	0.065	0.044	0.043	0.042	0.041	0.039	0.037
RURAL	RATE	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.018	0.018	0.017	0.012	0.007	0.007	0.006	0.006	0.008	0.005
PER LABOUR GNP	MIL W	1.05	1.08	1.12	1.18	1.24	1.30	1.37	1.44	1.52	1.60	1.77	1.95	2.20	2.49	2.81	3.89	5.55
URBAN	MIL W	1.36	1.40	1.46	1.53	1.60	1.67	1.75	1.83	1.92	2.01	2.19	2.40	2.67	2.99	3.34	4.49	6.27
RURAL	MIL W	0.71	0.72	0.76	0.79	0.83	0.87	0.91	0.95	1.00	1.05	1.13	1.23	1.36	1.51	1.69	2.28	3.23
P C GNP	1000 $	0.78	0.83	0.88	0.93	0.98	1.04	1.10	1.16	1.23	1.30	1.46	1.64	1.85	2.09	2.37	3.32	4.77
GNP GROWTH	RATE	0.054	0.075	0.075	0.075	0.075	0.075	0.074	0.074	0.074	0.074	0.075	0.076	0.076	0.077	0.078	0.081	0.086

Appendix table 18

Major indicators: (assumption M–1)

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	199			
POPULATION	1000	38 706	39 302	39 913	40 541	41 183	41 833	42 487	43 139	43 786	44 426	45 678	46 892	48 060	49 16(			
URBAN	1000	22 721	23 732	24 670	25 625	26 594	27 569	28 543	29 511	30 466	31 406	33 236	35 002	36 704	38 322			
RURAL	1000	15 986	15 571	15 244	14 915	14 588	14 264	13 944	13 628	13 320	13 020	12 441	11 890	11 356	10 838			
POP GROWTH	1/1000	15.2	15.3	15.4	15.6	15.7	15.7	15.5	15.2	14.9	14.5	13.7	12.9	12.1	11.0			
URBAN	1/1000	19.0	19.0	19.2	19.5	19.7	19.6	19.3	18.8	18.2	17.6	16.3	15.3	14.3	13.1			
RURAL	1/1000	10.0	9.9	9.6	9.2	8.9	8.5	8.2	7.9	7.7	7.5	7.0	6.3	5.3	4.1			
CBR	1/1000	22.6	22.7	22.7	22.7	22.7	22.6	22.4	22.1	21.8	21.3	20.5	19.8	19.0	18.0			
URBAN	1/1000	25.2	25.1	25.2	25.4	25.4	25.2	24.9	24.3	23.7	23.0	21.8	20.8	19.8	18.8			
RURAL	1/1000	19.2	19.2	18.9	18.5	18.2	17.9	17.7	17.6	17.5	17.4	17.3	16.9	16.4	15.6			11.2
CDR	1/1000	6.3	6.3	6.2	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.8	5.9	6.0	6.5	7.0
URBAN	1/1000	5.1	5.0	4.9	4.7	4.6	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.5	4.6	4.7	5.2	5.8
RURAL	1/1000	8.1	8.1	8.2	8.2	8.2	8.3	8.4	8.6	8.7	8.8	9.2	9.6	9.9	10.4	10.9	12.4	13.9
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
TFR	RATE	2.699	2.630	2.568	2.512	2.462	2.418	2.377	2.341	2.308	2.279	2.229	2.189	2.156	2.128	2.106	2.065	2.040
URBAN	RATE	2.530	2.483	2.440	2.401	2.366	2.334	2.304	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.036
RURAL	RATE	3.033	2.942	2.859	2.783	2.714	2.651	2.593	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.20	1.17	1.16	1.14	1.12	1.10	1.09	1.07	1.06	1.04	1.03	1.01	1.00	1.00	0.98	0.97
URBAN	1/1000	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.99	0.98	0.97
RURAL	1/1000	1.38	1.34	1.31	1.28	1.25	1.23	1.20	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.604	0.618	0.632	0.646	0.659	0.672	0.684	0.696	0.707	0.728	0.746	0.764	0.780	0.794	0.827	0.855
NET MIGRATION	RATE	0.012	0.015	0.012	0.012	0.011	0.011	0.010	0.010	0.009	0.009	0.008	0.007	0.007	0.006	0.006	0.005	0.004
URBAN	RATE	0.021	0.025	0.020	0.019	0.018	0.017	0.016	0.015	0.014	0.013	0.011	0.010	0.009	0.008	0.007	0.006	0.004
RURAL	RATE	0.028	0.036	0.030	0.031	0.031	0.031	0.030	0.030	0.030	0.030	0.029	0.029	0.028	0.027	0.027	0.026	0.025
DEPENDENCY	RATIO	0.594	0.581	0.568	0.555	0.542	0.530	0.520	0.514	0.509	0.506	0.505	0.503	0.496	0.489	0.481	0.456	0.434
URBAN	RATIO	0.534	0.534	0.526	0.519	0.510	0.502	0.496	0.492	0.489	0.488	0.489	0.487	0.479	0.466	0.454	0.425	0.408
RURAL	RATIO	0.687	0.660	0.642	0.620	0.602	0.587	0.573	0.563	0.555	0.550	0.548	0.552	0.556	0.580	0.594	0.621	0.809
F1544/FTOTAL	RATIO	0.482	0.484	0.486	0.488	0.491	0.493	0.495	0.495	0.496	0.496	0.494	0.490	0.490	0.488	0.485	0.470	0.451
URBAN	RATIO	0.538	0.536	0.535	0.535	0.536	0.537	0.537	0.535	0.535	0.533	0.528	0.523	0.521	0.520	0.515	0.494	0.470
RURAL	RATIO	0.402	0.405	0.406	0.408	0.409	0.409	0.409	0.408	0.409	0.408	0.403	0.396	0.390	0.380	0.373	0.357	0.344
NO OF FAMILY	NUMBER	8 428	8 667	8 912	9 165	9 426	9 693	9 966	10 243	10 524	10 808	11 383	11 968	12 561	13 155	13 746	15 219	16 747
URBAN	NUMBER	5 119	5 407	5 684	5 970	6 266	6 569	6 877	7 190	7 507	7 825	8 468	9 119	9 779	10 439	11 100	12 783	14 492
RURAL	NUMBER	3 309	3 260	3 228	3 194	3 160	3 124	3 089	3 053	3 018	2 983	2 915	2 849	2 782	2 715	2 646	2 456	2 255
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.840	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	14 779	15 505	15 875	16 300	16 670	17 037	17 379	17 701	18 017	18 316	18 852	19 358	19 840	20 288	20 771	21 981	22 932
URBAN	NUMBER	7 904	8 440	8 831	9 261	9 679	10 105	10 521	10 929	11 336	11 733	12 497	13 249	13 997	14 722	15 454	17 224	18 741
RURAL	NUMBER	6 875	7 065	7 044	7 039	6 991	6 931	6 858	6 772	6 681	6 583	6 356	6 109	5 843	5 566	5 317	4 737	4 211
LABOUR FORCE	RATE	0.571	0.584	0.584	0.585	0.584	0.583	0.582	0.581	0.581	0.581	0.580	0.577	0.573	0.567	0.563	0.553	0.545
URBAN	RATE	0.514	0.525	0.526	0.527	0.528	0.528	0.529	0.530	0.532	0.534	0.536	0.536	0.534	0.533	0.531	0.528	0.523
RURAL	RATE	0.653	0.676	0.677	0.682	0.684	0.685	0.687	0.688	0.690	0.692	0.693	0.691	0.692	0.686	0.682	0.673	0.668
LF HIGH GRD	RATIO	0.241	0.251	0.259	0.268	0.276	0.284	0.293	0.301	0.310	0.319	0.336	0.353	0.368	0.383	0.398	0.438	0.475
URBAN	RATIO	0.335	0.340	0.345	0.350	0.355	0.360	0.366	0.371	0.377	0.383	0.396	0.407	0.418	0.429	0.441	0.472	0.506
RURAL	RATIO	0.109	0.116	0.121	0.127	0.134	0.140	0.147	0.154	0.161	0.168	0.183	0.197	0.210	0.222	0.235	0.285	0.297
UNEMPLOYMENT	RATE	0.052	0.055	0.052	0.053	0.054	0.055	0.054	0.053	0.052	0.051	0.037	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.086	0.081	0.081	0.081	0.081	0.079	0.077	0.074	0.071	0.052	0.041	0.040	0.039	0.038	0.037	0.036
RURAL	RATE	0.017	0.018	0.016	0.017	0.016	0.016	0.016	0.015	0.015	0.014	0.009	0.006	0.006	0.006	0.005	0.005	0.005
PER LABOUR GNP	MIL W	1.05	1.08	1.13	1.18	1.24	1.31	1.38	1.45	1.53	1.61	1.78	1.99	2.24	2.53	2.86	3.95	5.64
URBAN	MIL W	1.36	1.40	1.47	1.53	1.60	1.67	1.75	1.83	1.92	2.01	2.19	2.42	2.69	3.01	3.36	4.52	6.31
RURAL	MIL W	0.71	0.71	0.73	0.75	0.78	0.81	0.84	0.87	0.91	0.94	1.00	1.08	1.19	1.31	1.46	1.96	2.79
P C GNP	1000 $	0.78	0.83	0.88	0.93	0.98	1.04	1.10	1.16	1.23	1.30	1.46	1.64	1.85	2.09	2.38	3.32	4.77
GNP GROWTH	RATE	0.054	0.075	0.075	0.075	0.075	0.075	0.074	0.074	0.074	0.074	0.074	0.074	0.075	0.076	0.077	0.080	0.086

Appendix table 19

Major indicators: (assumption M–2)

	UNIT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1992	1994	1996	1998	2000	2005	2010
POPULATION	1000	38 706	39 302	39 914	40 543	41 188	41 841	42 499	43 155	43 807	44 451	45 711	46 933	48 108	49 212	50 232	52 465	54 486
URBAN	1000	22 721	23 355	23 935	24 672	25 436	26 235	27 046	27 859	28 680	29 500	31 332	33 132	34 872	36 540	38 128	41 794	45 176
RURAL	1000	15 986	15 948	15 979	15 870	15 752	15 607	15 453	15 296	15 126	14 951	14 379	13 801	13 236	12 672	12 103	10 671	9 309
POP GROWTH	1/1000	15.2	15.3	15.4	15.6	15.8	15.8	15.6	15.3	15.0	14.6	13.8	13.0	12.1	11.1	10.0	8.1	7.4
URBAN	1/1000	19.0	19.0	19.4	19.7	19.7	19.5	19.0	18.5	17.7	17.0	15.6	14.6	13.8	12.9	11.9	10.2	9.5
RURAL	1/1000	10.0	9.9	9.5	9.6	9.7	9.7	9.8	9.8	9.9	10.0	10.0	9.3	7.9	6.1	4.1	–0.2	–2.5
CBR	1/1000	22.6	22.7	22.7	22.8	22.8	22.7	22.5	22.2	21.8	21.4	20.6	19.8	19.0	18.1	17.1	15.6	15.5
URBAN	1/1000	25.2	25.1	25.5	25.6	25.4	25.2	24.7	24.1	23.4	22.6	21.2	20.2	19.4	18.6	17.8	16.6	16.4
RURAL	1/1000	19.2	19.2	18.7	18.6	18.7	18.7	18.8	18.9	19.1	19.2	19.4	19.0	18.0	16.6	15.0	12.1	11.2
CDR	1/1000	6.3	6.3	6.2	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.8	5.9	6.0	6.5	7.0
URBAN	1/1000	5.1	5.0	4.9	4.8	4.7	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.6	4.8	5.2	5.8
RURAL	1/1000	8.1	8.1	8.1	7.9	7.9	7.9	7.9	8.0	8.0	8.1	8.3	8.7	9.0	9.4	9.8	11.2	12.8
EMIGRATION	1/1000	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
TFR	RATE	2.699	2.630	2.571	2.519	2.471	2.427	2.388	2.352	2.319	2.290	2.240	2.198	2.162	2.134	2.109	2.066	2.040
URBAN	RATE	2.530	2.483	2.440	2.401	2.366	2.334	2.304	2.277	2.253	2.230	2.191	2.159	2.132	2.110	2.091	2.057	2.036
RURAL	RATE	3.033	2.942	2.859	2.783	2.714	2.651	2.593	2.541	2.493	2.449	2.373	2.310	2.258	2.214	2.178	2.112	2.071
NRR	1/1000	1.23	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.05	1.03	1.02	1.01	1.00	0.98	0.97
URBAN	1/1000	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.02	1.01	1.00	1.00	0.99	0.98	0.97
RURAL	1/1000	1.38	1.34	1.31	1.28	1.25	1.23	1.20	1.18	1.16	1.14	1.11	1.08	1.06	1.04	1.03	1.00	0.99
URBANIZATION	RATE	0.587	0.594	0.600	0.609	0.618	0.627	0.636	0.646	0.655	0.664	0.685	0.706	0.725	0.742	0.759	0.797	0.829
NET MIGRATION	RATE	0.012	0.005	0.003	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.012	0.009	0.008	0.007	0.007	0.005	0.004
URBAN	RATE	0.021	0.009	0.005	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.017	0.013	0.011	0.010	0.009	0.007	0.005
RURAL	RATE	0.028	0.012	0.008	0.016	0.017	0.019	0.019	0.020	0.021	0.021	0.036	0.029	0.029	0.028	0.027	0.026	0.025
DEPENDENCY	RATIO	0.594	0.581	0.568	0.555	0.542	0.530	0.520	0.514	0.509	0.507	0.506	0.504	0.498	0.491	0.482	0.456	0.434
URBAN	RATIO	0.534	0.530	0.527	0.521	0.514	0.507	0.500	0.497	0.494	0.492	0.493	0.487	0.475	0.464	0.451	0.425	0.409
RURAL	RATIO	0.687	0.662	0.635	0.610	0.589	0.572	0.557	0.547	0.539	0.537	0.533	0.547	0.561	0.576	0.590	0.595	0.589
F1544/FTOTAL	RATIO	0.482	0.484	0.486	0.488	0.491	0.493	0.494	0.495	0.496	0.496	0.493	0.490	0.489	0.488	0.484	0.470	0.452
URBAN	RATIO	0.538	0.536	0.534	0.532	0.532	0.532	0.532	0.530	0.529	0.528	0.523	0.520	0.520	0.518	0.514	0.494	0.472
RURAL	RATIO	0.402	0.407	0.414	0.420	0.424	0.427	0.429	0.431	0.433	0.433	0.429	0.418	0.409	0.401	0.393	0.377	0.358
NO OF FAMILY	NUMBER	8 428	8 660	8 898	9 147	9 405	9 669	9 940	10 215	10 493	10 775	11 352	11 939	12 533	13 129	13 722	15 199	16 732
URBAN	NUMBER	5 119	5 321	5 514	5 748	5 993	6 251	6 517	6 788	7 067	7 350	7 983	8 632	9 290	9 954	10 621	12 308	14 066
RURAL	NUMBER	3 209	3 339	3 384	3 399	3 412	3 418	3 423	3 427	3 427	3 425	3 369	3 307	3 243	3 175	3 101	2 891	2 668
HIGH S ENROL	RATIO	0.705	0.721	0.738	0.752	0.766	0.780	0.794	0.809	0.825	0.839	0.863	0.879	0.890	0.900	0.910	0.934	0.954
LABOUR FORCE	NUMBER	14 779	15 534	15 941	16 394	16 791	17 184	17 551	17 898	18 237	18 558	19 121	19 625	20 117	20 564	21 041	22 231	23 231
URBAN	NUMBER	7 904	8 327	8 573	8 910	9 241	9 592	9 939	10 284	10 637	10 988	11 731	12 517	13 297	14 040	14 798	16 605	18 175
RURAL	NUMBER	6 875	7 207	7 368	7 484	7 550	7 592	7 612	7 614	7 600	7 570	7 389	7 108	6 820	6 524	6 243	5 626	5 056
LABOUR FORCE	RATE	0.571	0.586	0.586	0.588	0.588	0.588	0.588	0.588	0.588	0.589	0.589	0.585	0.581	0.575	0.570	0.560	0.551
URBAN	RATE	0.514	0.525	0.526	0.527	0.527	0.528	0.528	0.529	0.530	0.532	0.535	0.534	0.534	0.532	0.530	0.527	0.523
RURAL	RATE	0.653	0.675	0.676	0.681	0.684	0.686	0.689	0.691	0.694	0.697	0.701	0.702	0.702	0.698	0.694	0.685	0.681
LF HIGH GRD	RATIO	0.241	0.251	0.259	0.268	0.276	0.285	0.293	0.302	0.310	0.319	0.337	0.353	0.368	0.383	0.398	0.456	0.475
URBAN	RATIO	0.335	0.341	0.349	0.355	0.361	0.367	0.373	0.379	0.385	0.392	0.404	0.415	0.425	0.436	0.447	0.478	0.511
RURAL	RATIO	0.109	0.116	0.123	0.130	0.138	0.146	0.154	0.162	0.171	0.179	0.194	0.208	0.220	0.231	0.242	0.272	0.304
UNEMPLOYMENT	RATE	0.052	0.056	0.054	0.056	0.057	0.059	0.059	0.058	0.058	0.057	0.044	0.030	0.030	0.030	0.030	0.030	0.030
URBAN	RATE	0.083	0.089	0.086	0.088	0.089	0.090	0.089	0.088	0.087	0.084	0.064	0.043	0.042	0.041	0.040	0.038	0.037
RURAL	RATE	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.018	0.018	0.017	0.012	0.007	0.006	0.006	0.006	0.005	0.005
PER LABOUR GNP	MIL W	1.05	1.08	1.12	1.18	1.24	1.30	1.37	1.44	1.52	1.60	1.77	1.96	2.21	2.50	2.83	3.91	5.58
URBAN	MIL W	1.36	1.40	1.46	1.53	1.60	1.67	1.75	1.83	1.92	2.01	2.19	2.40	2.67	2.99	3.35	4.50	6.28
RURAL	MIL W	0.71	0.72	0.76	0.79	0.83	0.87	0.91	0.95	1.00	1.05	1.12	1.21	1.33	1.47	1.64	2.21	3.14
P C GNP	1000 $	0.78	0.83	0.88	0.93	0.98	1.04	1.10	1.16	1.23	1.30	1.46	1.64	1.85	2.09	2.37	3.32	4.77
GNP GROWTH	RATE	0.054	0.075	0.075	0.075	0.075	0.075	0.074	0.074	0.074	0.074	0.074	0.075	0.075	0.076	0.077	0.080	0.086

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Part Three

DEMOGRAPHIC-ECONOMIC MODEL BUILDING FOR JAPAN

by

Naohiro Ogawa, Akira Sadahiro,
Makoto Kondo and Mitsuo Ezaki*

* This paper is a joint product of the work of four authors. Naohiro Ogawa prepared chapters IX, XI, XIV and XV and edited all the chapters. Akira Sadahiro was responsible for chapter XIII, Makoto Kondo for chapter XII and Mitsuo Ezaki for chapter X.

Chapter IX

JAPANESE DEMOGRAPHIC CONTEXT AND MODELLING

Subsequent to the post-war baby boom, the fertility level of the Japanese population declined drastically in the 1950s. The crude birth rate dropped from 34.5 to 17.2 over the period of 1947-1957, as shown in Table IX.1. Throughout the 1960s and until 1973, fertility remained at a low level. After the first oil crisis of 1973, however, the birth rate again started falling and this trend is still continuing. It is equally important to note that mortality fell substantially in post-war Japan, as clearly indicated in Table IX.1. The crude death rate dropped from 14.7 per thousand persons in 1947 to 7.8 in 1955, and has been on a gradual downward trend thereafter. Due to these demographic changes, the population of Japan has been aging at an extremely fast rate. The proportion of those aged 65 and over was only 4.8 per cent in 1947. In 1980, it increased to 8.9 per cent and will exceed a 20 per cent level in the early part of the next century. Figure IX.1 demonstrates that as compared with the speed of population aging in other industrialized countries, the tempo of the aging of the Japanese population is unprecedentedly fast. It has been quantitatively demonstrated that the primary source of this aging was fertility reduction, and not mortality improvements [41].

This rapid population aging has recently created various problems at both macro and micro levels. Because the population aging process will accelerate in the decades to come, the seriousness of the problems arising from such population aging will be considerably aggravated. In the realm of public policy measures, substantial transformations have been called for as a result of an increasing number of aged persons. Both medical and old-aged pension schemes are salient examples of these public programmes.

One method for measuring the effect of such population aging is the modelling approach. There are two types of modelling: short-term and long-term. Long-term models are distinguished from short-term ones mainly by the sample period. In the case of Japanese models, the sample period of short-term models is always limited to the postwar years, while that of long-term models covers mostly the prewar period going back even to the Meiji era. However, long-term models are contrasted with short-term ones on many scores other than the sample period. First, the objective of short-term models lies often in forecasting and policy evaluations in the short-run, while

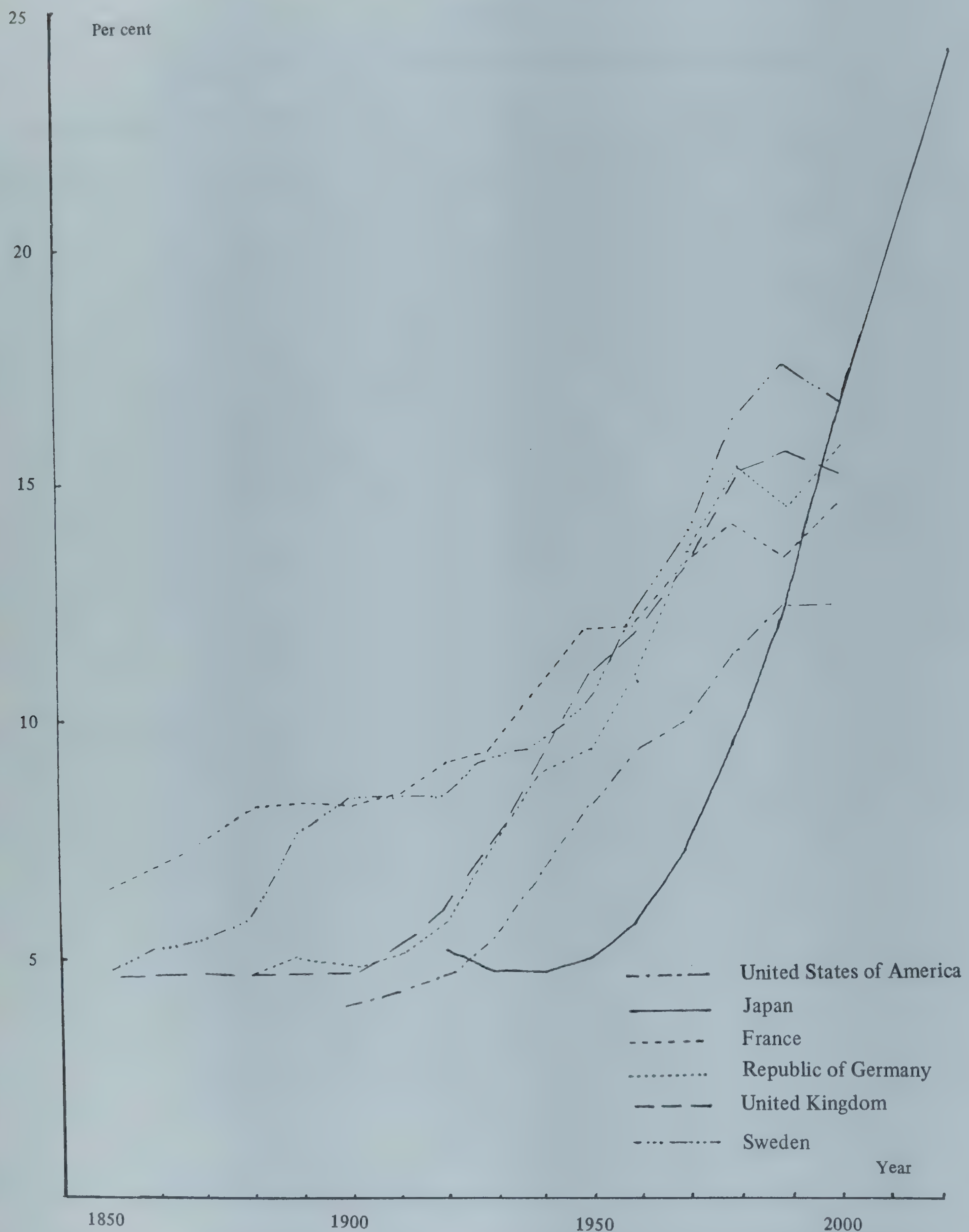
Table IX.1. Selected vital rates for Japan, 1947-1980

Year	Crude birth rate	Crude death rate
1947	34.3	14.6
1948	33.5	11.9
1949	33.0	11.6
1950	28.1	10.9
1951	25.3	9.9
1952	23.4	8.9
1953	21.5	8.9
1954	20.0	8.2
1955	19.4	7.8
1956	18.4	8.0
1957	17.2	8.3
1958	18.0	7.4
1959	17.5	7.4
1960	17.2	7.6
1961	16.9	7.4
1962	17.0	7.5
1963	17.3	7.0
1964	17.7	6.9
1965	18.6	7.0
1966	13.7*	6.8
1967	19.4	6.8
1968	18.6	6.8
1969	18.5	6.8
1970	18.8	6.9
1971	19.2	6.6
1972	19.3	6.5
1973	19.4	6.6
1974	18.6	6.5
1975	17.1	6.3
1976	16.3	6.3
1977	15.5	6.1
1978	14.9	6.1
1979	14.2	6.0
1980	13.6	6.2

Source: Health and Welfare Statistics and Information Department, Ministry of Health and Welfare, *Vital Statistics*, various issues.

* This irregularity is that 1966 was the year of the "Fire Horse," which comes around every 60 years. This long-standing Japanese superstition says that a female born in this particular year is destined to an unhappy life and will kill her husband if she marries.

Figure IX. 1. Percentage of aged population to total population in selected countries



Source: All data up to 1950 are collected from *The Aging of Population and Its Economic and Social Implications* (United Nations publication, Sales No. 56.XIII.6). Data for 1960-2000 are gleaned from *Selected Demographic Indicators By Country, 1950-2000: Demographic Estimates and Projections As Assessed in 1978* (ST/ESA/SER.R/38). Data for Japan for 1980-2020 are based on the Standard Case of the present study.

that of long-term models is either to clarify development patterns and structural changes historically or to make long-run projection for planning and policy purposes. Secondly, the data are quarterly or semi-annual for short-term models and annual or moving averages for long-term ones. Third, from the point of view of the theoretical background, short-term models are basically of the Keynesian effective demand type, while long-term models are mostly of the neo-classical supply-oriented type. Fourth, the performance of short-term models is judged from the traceability of short-run business cycles, while that of long-term models is judged from the recapitulation of long-run growth patterns and structural changes.

It should be noted that because demographic factors are, by and large, of a long-run nature, one tends to employ long-term models for the analysis of demographic changes. In the present study, therefore, we will analyze, by drawing upon a long-term demographic-economic model developed for Japan, the effect of the aging of the Japanese population upon various aspects of the economy and government programmes. The quantitative analysis of the interrelationship between age-structural changes and the socio-economic system may provide a useful basis for Japanese government planners to formulate proper policy measures to cope with numerous problems likely to arise in connection with the aging of the population. Moreover, the modelling exercise, based upon the Japanese context, will provide development planners in developing countries with a number of useful insights into the problems of integrating socio-economic factors and demographic variables into development planning. Because of its abundance of both time-series and cross-sectional data, modelling work for Japan can be fairly elaborate and complex; it could provide a useful base for other Asian countries to develop quantitative frameworks for their long-term development and population planning schemes.

In the next section, the role of demographic factors in several major long-term macro-economic models developed for Japan is discussed. In Section III, the demographic component of the model of the present study is described, and in the ensuing two sections, both economic and social security components of the model are presented in great detail. In Section VI, the results of selected simulation experiments are presented. In Section VII, the policy implications of these experiments are considered from various angles, so as to provide a useful basis for the formulation of effective long-range government policies to cope with the number of serious problems likely to occur in the process of rapid population aging in the next several decades.

The present study draws upon the following three submodels: the population submodel, the economic submodel and the social security submodel. As shown in Figure IX.2. these three submodels are interdependent; the demographic submodel is first determined by a set of economic and social security variables with a one-year time lag, and then both economic and social security submodels are determined by selected demographic variables. Most of the functional relationships incorporated in these submodels have been estimated by ordinary least squares (OLS) on the basis of time-series data.

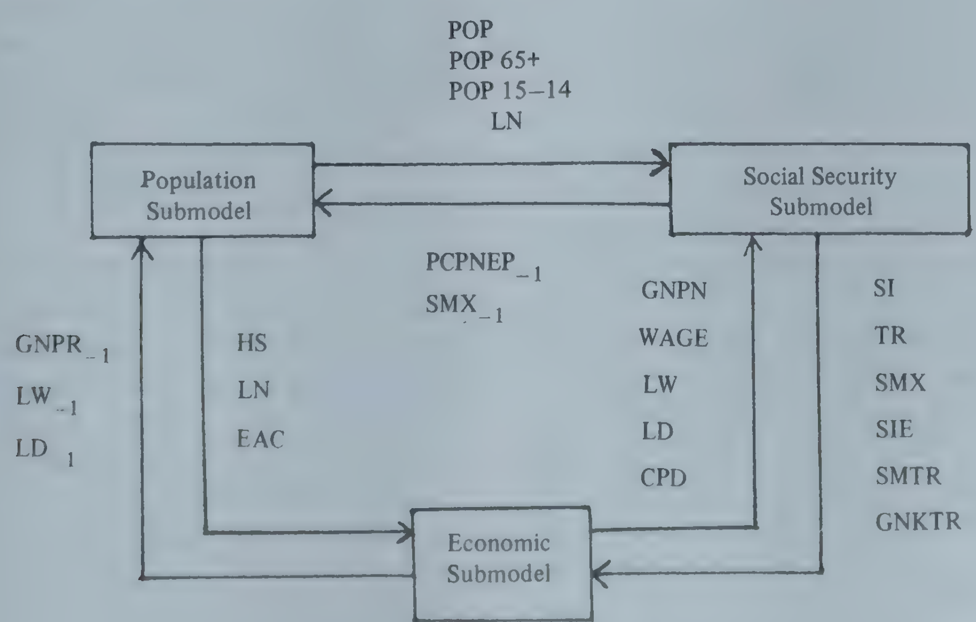


Figure IX.2. Theoretical linkage among three submodels

Chapter X

REVIEW OF MACRO-ECONOMETRIC MODELS FOR JAPAN WITH PARTICULAR REFERENCE TO LONG-TERM MODELS AND THE ROLE OF DEMOGRAPHIC FACTORS

A. INTRODUCTION: A GENERAL OUTLOOK

This is a short review of Japanese macro-econometric models focusing on the models of a long-term nature and the role of demographic factors in those models. This review owes much to the following three review articles: Moriguchi [38], Tokoyama [55] and Ogawa [40], especially to the second which gives comprehensive and quite suggestive evaluations of the Japanese long-term models.

In Japan, econometric model building which began around the middle of the 1950s, aims at practical applications of the Keynesian income determination theory to the Japanese economy. TCER Model I, which was made public in 1957 by the Tokyo Center of Economic Research, is a pioneering effort for a series of important modelling works in the first half of the 1960s. During this peiod, economists and policy makers were very much concerned about relationships between growth and balance of payments, changes in industrial structure and labour supply, high rates of capital formation and private savings, historical patterns of economic development, etc. Modelling efforts to attack these problems were actively made in various directions taking off from simple Keynesian models of income determination. Typical examples during this period are include the MITI Model III [24], the TCER Model V [37], the Osaka University Model [12], the Klein Model [33], the Klein-Shinkai Model [34], and the Nagoya University Model [57] [59]. The first three of then are the short-term models in which the evaluation of policy effects, the analysis of business cycles and the forecasting in the short-run have been attempted. The Osaka University Model, in particular, is an ambitious large scale quarterly model which determines production, exports, employment and wage levels simultaneously for individual industries classified by scale. Although it was not completed (see [13] for a more complete explanation), it gave many lessons and incentives to the successive development of quarterly models as well as of multi-sectoral models in later years. The remaining three are the long-term models whose development was initiated with the coming of L.R. Klein to Japan in 1960 as a momentum. He constructed two econometric models during his stay in Japan. One is a model of neoclassical nature aiming at the analysis of Japanese economic development in the ultra-long-run (Klein Model). Another is a model of effective demand type with a nature of medium-term model (Klein-Shinkai Model). The two models greatly influenced the development and improvement of Japanese econometric models. The latter, in particular, gave impetus to a series of modelling works at Nagoya University (Nagoya University Model).

In the latter half of the 1960s, there emerged diversifications and specializations in the Japanese macro-econometric models, depending on their objectives. The models during this period may be classified largely into three categories. First is the forecasting and policy models constructed for planning, policy evaluation and forecasting purposes. A typical example in this category is the Medium-Term Macro-model which provided the medium-term economic plan of 1965 with a quantitative basis [54]. It is not only a planning model but also a forecasting model. Its theoretical framework is succeeded by and closely related to the JERC quarterly model, by which the Japan Economic Research Center makes public its short-run forecasting results on a regular basis.

Second is the regional econometric models constructed for the analysis of regional economies and regional development either covering all regions or focusing on a particular region in the national economy. An example is the EPA Regional Model which is a nation-wide regional development model covering all 9 regions in the Japanese economy [18]. It deals with industrial production, income distribution and expenditures in each region, and explains transactions between regions by a gravity model.

Third are the sectoral models that emphasize such specific aspects in the national economy as trade and finance. Models for the trade sector, (trade models) generally took the form of submodels which are not complete in themselves but provide a detailed analytical framework for the trade sector in relation to the main models. Examples of the trade submodels include the Osaka University Model [11] and the Medium-Term Macromodel [53]. Models for the financial sector (financial models) on the other hand, were sometimes self-contained with detailed treatment of the financial sector and sometimes not. Examples of the former are the Eguchi Model [5], and the Hamada Model [8],

while examples of the latter are the financial submodels of such models as the Osaka University Model [10], and the Medium-Term Macromodel [62].

In the 1970s continuous efforts were made to develop and improve large scale macro-econometric models which, in turn, has made it possible to analyse the national economy in as much detail as possible, explicitly allowing for the interrelationships between sectors or blocks in the economy. Models of this type, i.e., multi-sectoral models, not only rely on the framework of input-output tables explicitly or implicitly but also disaggregate the national economy into many component sectors or blocks such as households, private business, government, foreign, production, labour, financial, wages and prices, etc. Typical examples of the multi-sectoral models are the Saito Model [48], the Keio University Model [56], the Ueno-Muto Model [61], the Econometric Committee Model [17], and the MOSSY Model [21]. The first two are general equilibrium systems with heavy reliance on the input-output framework, while the third is not an equilibrium system but has price adjustment mechanisms under the inter-industry framework. The fourth is a medium-term planning model which was used for the formulation of the economic plan for 1976-1980. It is an extension of the Medium-Term Macromodel combined with inter-industry model. The last MOSSY Model (Model of the Social Security System) deals with the social security system in great detail aiming at the analysis of social security policy in the medium-run. It is similar in nature to the financial models of the self-contained type in that it emphasizes a particular block within a nationwide macro-econometric model.

These multi-sectoral models are mostly of a relatively large scale as a natural consequence of the attempt to endogenize as many variables in the national economy as possible. In the 1970s, econometric models developed also in the direction of endogenizing such world variables as total world trade, world export prices, import prices of individual countries etc., aiming at the analysis of economic transmission and interdependence between countries in the world. Models of this type, i.e., world models or link systems, were initiated by L.R. Klein and his associates under Project LINK around the end of the 1960s. The system of Project LINK, in which country and regional models are linked together through trade models, employs the Kyoto University Model [38] as the country model for Japan. World models constructed in Japan independently of Project LINK are the FUGI Model [29], and the Tsukuba University Model [50], the EPA World Econometric Model [2] [19], of which the last is an ongoing project at the Economic Planning Agency to be used for policy purposes of the Japanese government which faces an increasingly rapid interdependent world. It seems worthwhile, in relation with the world models, to refer to the Kobe University FLEX Model [1], which is based on the balance of payments block of the country models in the EPA World Econometric Model. The FLEX Model was developed as an attempt to endogenize the exchange rate under the current flexible exchange rate system. It is not only a compact model consisting of less than 60 equations but also a strategic model focusing on the mechanism of exchange rate determination with other aspects of the economy limited to the necessary minimum. Its favourable performance in forecasting (especially on the exchange rate as demonstrated by the accurate forecasting of the depreciation of yen in 1978) indicates the usefulness of this kind of compact strategic model, especially in dealing with specific problems.

In the 1970s efforts were made also to develop and improve long-term macro-econometric models for the study of historical patterns and structural changes in the Japanese economic development. Examples of the long-term models during this decade are the Ueno Model [58], the Shinoya-Yamasawa Model [49], the Ishiwata-Odaka Model [14] [15], and the Minami-Ono Model [35] [36]. The first one is the two-sector model of a neoclassical nature which is an extension of the Nagoya University Model. The remaining three are all based on the long-term economic statistics (LTES) of Hitotsubashi University, focusing respectively on trade and industrialization, demand and trend acceleration, and employment and wage under the dual structure of the Japanese economy.

B. LONG-TERM MODELS OF JAPANESE ECONOMIC DEVELOPMENT

The long-term macro-econometric models in Japan were developed side by side with the short-term ones as described in the previous section. Here we will review, in some detail, some of the models of long-term economic development, referrring to their structures, theoretical backgrounds and demographic factors.

The Klein Model [33] was constructed under the circumstances of very limited data availability. Its observation period 1878-1937 is the longest among the models for the Japanese economy. The data before 1900 were available only for the income of the production side estimated by K. Ohkawa [45] [46], so that it was impossible to construct a model of effective demand type at that time. Klein, therefore, supplemented the production data by trade and demographic statistics. He

pointed out four characteristics about the Japanese economy to be considered in the model building: food imports, importance of trade, population change and labour movements, and high rates of savings and growth.

The basic structure of the Klein Model may be summarized as follows (with the notation of Tokoyama [55] similar to that of other models which will be discussed subsequently):

(1)	$X_1 = X_1(L_1)$	: Production function for agriculture
(2)	$X_2 = X_2(L_2)$	: Production function for non-agriculture
(3)	$D_1 = D_1(X, N)$	: Demand function
(4)	$D_2 = D_2(M\text{-}M_1)$	: "
(5)	$X_1 + M_1 = D_1$	: Equilibrium condition
(6)	$X_2 = D_2$	: "
(7)	$L_1 + L_2 = L$	: Total labour
(8)	$X_1 + X_2 = X$	: Total output or total income
(9)	$L = L(N)$	: Labour force participation
(10)	$N = N(d, b)$	: Total population
(11)	$b = b(X/N)_{-1}$	: Birth rate
(12)	$d = d(X/N)_{-1}$	: Death rate
(13)	$M = \bar{p}_f \cdot \bar{E}$	: Trade equilibrium in terms of import goods

Note that the demand for agricultural products is specified as an Engel function (i.e., $\ln(D_1/X) = \alpha - \beta \ln(X/N)$, while the demand for non-agricultural products is determined by a surplus ability to import raw materials and capital goods (i.e., $M\text{-}M_1$). Equilibrium conditions are realized in the model through labour shifts between sectors (under full employment assumption) and imports. When the equations from (9) to (13) are dropped, the system becomes quite similar to the neoclassical two-sector model. Neither capital nor price determination is explicity allowed for in the model but its assumption of full employment implies the neoclassical mechanism of economic growth.

The Klein Model, which lacks the mechanism of capital accumulation, has its dynamic factors only in the endogenous population growth through birth and death rates and the exogenous technical progress reflected by the trend increase in labour productivity. Therefore, it can be regarded as a model without a full incorporation of self-sustained economic development with dynamic growth mechanisms. Although the Klein Model, as a model of export-led growth, pinpointed an important aspect of the Japanese economic development in the prewar period, its neglect of the capital accumulation process caused a limitation to its forecasting power.

Subsequently, the Kelin Model became the prototype for the Ueno and Kinoshita Model [59] [60]. The Ueno-Kinoshita Model consists of 39 equations, focusing on three commodities: food (F), textiles (T), and heavy industry products (H). Because the model is based on the production indices of these commodities, it is not a macro-model of the ordinary type. This is due to the data limitations. However, the choice of the three commodities facilitated the understanding of model builders in the strategic role played by these products in the economic development of Japan.

The Ueno-Kinoshita Model may be summarized in a simplified form such as:

(1)	$X_F(L_F, K_F) + M_F = D_F(Y, N, \bar{P}_F)$	: Supply = demand
(2)	$X_T(L_T, K_T) = D_T(Y, N, P_T) + E_T(P_T)$	: "
(3)	$X_H(L_H, K_H) + M_H(E_H, D_H) = D_H(\Delta K, C_d) + E_H(P_H)$	: "
(4)	$Y = \Sigma p_i X_i$ (i = F, T, H, O (others))	: National income
(5)	$C_d = C_d(Y, p, L_m)$	: Demand for consumer durables
(6)	$\Delta K_i = I_i(\Pi_i, P_H)$ (i = T, H)	: Demand for investment goods
(7)	$\Pi_i = p_i X_i - w_i L_i$ (i = T, H)	: Profits
(8)	$L = \Sigma L_i$ (i = F, T, H, O)	: Total labour

(9)	$L/N = \Phi(Y/pN)$	: Labour force participation
(10)	$N = N(b, \bar{d})$	: Total population
(11)	$b = b(Y/pN)$	: Birth rate
(12)	$p = P(\bar{p}_F, p_T, p_H, p_O)$	: General price index
(13)	$p_i = p_i(w_i, (X_i/N_i)_{-1})$ $(i = T, H)$	: Price indices
(14)	$w_i = W_i(\bar{p}_F, (X_i/N_i)_{-1})$ $(i = T, H)$	: Wage indices
(15)	$L_M = \Psi(Y, p, \bar{i})$	: Cash balances
(16)	$\Delta K_i = K_{i,\, t+1} - K_{i,\, t}$ $(i = T, H)$	: Increase in capital stock
(17)	$B = p_E E - P_M M$	: Balance of trade

Equations (1) – (10) constitute an essential part of the model while the other equations are determined recursively except for the liquidity preference function (15).

Its correspondence with the Klein Model is self-explanatory. The Ueno-Kinoshita Model deviates from the Klein Model on several important points. One is the explicit introduction of capital stocks into production functions, by which the non-dynamic property of the Klein Model is more or less overcome. Another is the explicit allowance for various prices including wage rates. However, supply-demand equilibrium conditions are realized through labour shifts and food imports as in the case of the Klein Model. The last point is the non-limitational nature of balance of payments in the model.

The Ueno-Kinoshita Model recapitulates, to a considerable extent, growth and structural changes in the long-run development of the Japanese economy (1920-1961) as far as the three strategic industries are concerned. The model, however, is not sufficient enough to answer whether or not growth and cycles were generated autonomously, based on the internal mechanism of economic development because too many factors are treated as exogenous in the working of the model.

Klein and Shinkai [34] constructed a long-term of another version aiming at the analysis of structural changes for both prewar and postwar periods. Since a relatively short period 1930-1958 was employed as the observation period, it was possible to construct a model of effective demand type in spite of the general data shortages at that time. The basic structure of the model may be summarized as follows:

(1)	$C = C(Y, N, /W)$	: Consumption
(2)	$I = I(\Pi, K, \bar{i})$	: Investment
(3)	$E = E(\overline{TW}, \bar{p}_W)$	: Exports
(4)	$M_i = M_i(X_i)$ $(i = 1, 2, 3)$	: Imports (foods, materials, others)
(5)	$X_i = X_i(L_i)$	: Production function for agriculture
(6)	$X_2 = X_2(L_2, K)$	: Production function for non-agriculture
(7)	$L_2 = f(X_2, w/p, \Sigma M_i)$	: Employment in non-agriculture
(8)	$\dot{w} = \Psi(\dot{p}, U)$	: Increase in wage rate
(9)	$pY/\bar{L}_M = \phi(p, \bar{i})$	: Liquidity preference
(10)	$Y + \Sigma M_i = C + I + X$	: Supply = demand
(11)	$Y = \Pi + W$	: NNP
(12)	$Y = X_1 + X_2$	: NNP
(13)	$wL_2 = pW$	: Wage income

The Klein-Shinkai Model basically follows the Valavnis-Vail model of 1955 for the long-term development (1869-1953) of the U.S. economy, deviating, however, on two scores in relation to the characteristics of Japanese economy: the explicit introduction of exports and imports because of their strategic roles in development and the division of the national economy into two sectors for the analysis of dualistic structure. As regards the labour shifts from agriculture to non-agriculture, the Klein-Shinkai Model deviates decisively from both the Klein Model and the Ueno-Kinoshita Model in that the labour allocation between the two sectors is explained by real wages dealing explicitly

with the subjective motive of labourers. Therefore, supply-demand adjustments are realized, not through labour shifts, but through changes in national income, resulting in the abandonment of the full-employment assumption.

The Klein-Shinkai Model is more endogenized and more comprehensive than the Ueno-Kinoshita Model, as far as the framework of model is concerned. For this reason, it could become potentially a model of self-sustained autonomous development. In the light of the ex-post forecastings, however, the model was not satisfactory in recapitulating the actual economy for the postwar period. This is mainly due to the dummy variables introduced in structural equations representing the difference between prewar and postwar periods, which in turn, superficially raised the goodness of fit or co-efficients of determination of the model. The investment function was serious from this point of view and, according to T. Blumenthal [4], the forecasting power (in the ex-post sense) could be improved remarkably by treating investment as exogenous. The Klein-Shinkai Model indicates that a model of Keynesian effective demand type loses its validity for the analysis of long-run development in Japan if it fails to estimate a right investment function theoretically and statistically. Without such long-run investment functions, models for the Japanese economic development should at least clarify the process of production expansions. The neo-classical model is appropriate for this purpose, and the Ueno Model [58] is its typical example.

Long-term data on capital, labour, prices, etc. gradually became available from the middle of the 1960s in relation to the medium-term economic plan. These data made it possible for H. Ueno to construct a new model of a neo-classical type which may be considered as most comprehensive in scope among the long-term models of Japanese economic development. The model consists essentially of two blocks: production and investment. In the production block, the economy is divided into two sectors: primary and non-primary.

Neo-classical characteristics of the Ueno Model may be found in the following process of capital accumulation. For each year, GNP is determined in the production block under the full-employment assumption. GNP then determines the total capital formation through saving function in the investment block. Total capital formation is allocated by policy parameters to private and government investments. Part of private investment becomes investment in the non-primary sector through the investment function, while the remaining constitutes investment in the primary sector. Note that the causal relations above are one-way and the investment behaviour in a year is not fed back into the determination of GNP of that year. This is the main reason why the Ueno Model can be called a neo-classical model.

The Ueno Model is a system of 39 equations consisting of the production block at the center along with the investment block, exports and imports, prices, monetary equations, etc. Its observation period is 1905-1968, for which the model traces the actual economy reasonably well in the light of partial test. In the light of a final test for the postwar period, the performance of the model is favourable, especially for trend elements but not much so for cyclical elements. This is a natural result of the neo-classical model which focuses on the supply side through the process of capital accumulation. The Uneo Model, said to be the most comprehensive self-complete model with the longest time span, has recapitulated past experiences most faithfully among the long-term models for the Japanese economic development.

A long-term model of an effective demand type was constructed by S. Ishiwata and K. Odaka [15], aiming at a quantitative analysis of "trend acceleration" from the demand side. K. Ohkawa and H. Rosovsky advocated the concept of trend acceleration as a useful analytical tool for the analysis of Japanese economic development in the 20th century including the postwar period. They indicated that the accelerated growth of GNP or *per capita* GNP occurred several times in the upswing phases of the Japanese long-term business cycles. They related this trend acceleration to investment spurts, emphasizing the productive aspect of investment rather than its role of demand creation. S. Ishiwata and K. Odaka thus attempted to approach the trend acceleration in the prewar period (1906-1938) based on the effective demand model.

The Ishiwata-Odaka Model can be simplified as:

(1)	$Y = C + (I_p + \bar{I}_H + \bar{I}_G) + \bar{G} + X - M$	: GNP
(2)	$C = C(Y, \bar{N})$	: Private consumption
(3)	$I_p = I(r, K_p, \rho)$	: Private investment
(4)	$X = X(\bar{T}\bar{W}, \bar{p}_W/p \cdot \bar{e}, K)$	: Exports
(5)	$M = M(Y, \bar{p}_M/p)$	: Imports

(6) $Y^C_P = f(K_p, Z_1 \cdot \bar{t}, \bar{Z}_2 \cdot \bar{t}, \bar{Z}_3 \cdot \bar{t})$: Capacity output

(7) $Y_p = Y - \bar{Y}_G$: Private production

(8) $\rho = Y_p / Y^C_P$: Rate of operation

(9) $L_p = L(\rho K_p)$: Employment

(10) $w = w(p \cdot Y_p / L_p)$: Wage rate

(11) $r = (Y_p - w \cdot L_p / p) / K_p$: Profit rate

(12) $L_m = \Psi(p Y)$: Monetary function

where Z_1, Z_2 and Z_3 are dummy variables for 1906-1922, 1923-1931 and 1932-1938 respectively to allow for different rates in technical progress in the three subperiods.

In this system, each item in the expenditure side [eqs. (2) – (5)] determines the level of total demand (i.e., GNP) through multiplier processes, which in turn, determines the rate of operation in the private sector in combination with the level of capacity output to be determined by the production function (6). Total demand in this system, therefore, is always matched by total supply through the adjustments in the operation rate but not in prices. The general price level may be regarded as the adjustment factor to attain the monetary balances in the system. This demand-oriented model was applied for simulation purposes to the two subperiods of accelerated growth and investment spurts: 1906-1918 and 1931-1938. The simulation analysis revealed that government expenditure (G), terms of trade (e), and technical progress (Z_1, Z_3), in particular, had significant effects on the trend acceleration in the two subperiods. The model, however, is poor in the light of the final test, showing sustained biases for such key variables as GNP (Y), investment (I_p), and general price level (p). Furthermore, the model is not tested for its applicability to the trend acceleration in the postwar period. The Ishiwata-Odaka Model is thus left to be improved in many directions, a fact recognized by the model builders themselves.

R. Minami and A. Ono constructed, in contrast to the foregoing two models, a supply-oriented two-sector model of Japanese development, focusing on the dualistic structure in the prewar Japanese economy covering the period 1886-1940 [36]. There already existed several theoretical models for the Japanese dualistic development such as the Lewis model, the Fei-Ranis model and the Jorgenson model, of which the first was employed as a theoretical basis in the Minami-Ono Model. The Lewis model assumes the unlimited supply of labour from the subsistence sector to the capitalist sector under the institutionally fixed subsistence wage rate. The Minami-Ono Model follows this assumption but deviates from the classical model of the Lewis type in that it assumes that supply is always matched by demand. In other words, the labour supplied is all employed and the goods produced are all demanded, so that the limitation does not come from the demand side but from the supply side, equalizing demand with supply through adjustments in prices and wages. In this sense, the model is similar to the neo-classical two-sector model.

The structure of their supply-oriented model may be summaried in simplified for as:

(1) $V_1 = V_1(L_1, K_1, \bar{A})$: Production in primary sector

(2) $V_2 = V_2(L_2, K_2)$: Production in non-primary sector

(3) $L_2/L_1 = \phi(p_r \cdot w_2/w_1, V_2/V_1)$: Employment allocation

(4) $V_2/L_2 = \Psi(w_2)$: Demand for labour in non-primary sector

(5) $V = V_1 + p_r \cdot V_2$: Total income

(6) $W = w_1 L_1 + p_r w_2 L_2$: Total wage income

(7) $S = S(V/P_c, W/V)$: Saving function

(8) $I_2/I_1 = \theta(V_2/V_1)$: Investment allocation

(9) $I_1 + I_2 = S + \bar{B}_F$: Investment allocation

(10) $P_r = P_r(V_1, V_2)$: Terms of trade between two sectors

(11) $P_c = P_c(P_r)$: Relative consumer price index

(12) $w_1 = P_c \cdot \bar{w}$: Wage rate in primary sector

(13) $\bar{L} = L_1 + L_2$: Supply of labour = demand for labour

(14) $K_i = I_1 + (1 - \delta_i)K_{i,-1}$: Capital accumulation ($i = 1, 2$)

where A = cultivated area, $\overline{w}$ = institutionally fixed wage rate, and P_r and P_c = relative price indexes with primary products as the base.

The system may be divided into three blocks. The first is the production and employment block consisting of eqs. (1) – (4), in which the level of productions and the shifts of labour from primary to non-primary are determined in terms of P_r, w_1, and w_2. The second is the price and wage block consisting of eqs. (10 – (13), which determines four price variables in combination with the production and employment block. Note that the equilibrium in the labour market [eq. (13)] is attained by the adjustments in prices and wages. The third is the saving and investment block consisting of eqs. (5) – (9), in which total savings is allocated to the two sectors as investment expenditures, causing capital accumulation by eq. (14). Because the third block does not affect the other two blocks except through capital accumulation, the model is quite similar to the neo-classical two-sector model. Yet, the model has the nature of a classical model in the employment determination under institutionally fixed wage rate. The Minami-Ono Model may be said to be an interesting blend or mixture of the two models of an opposite nature: neo-classical and classical. The performance of the model is favourable in the light of a final test except for two price variables (p_r and p_c), and several interesting implications on the dualistic structure are derived from the simulation analysis.

There exist two other important modelling works for the Japanese economic development. One is the general equilibrium analysis of Kelly and Williamson [32], which relies on a theoretical model of dualistic development and the simulation method with parameter values assigned by experiences or theories but not estimated by ordinary econometric techniques. The other is the "great ratios" analysis of Nishikawa [39], which depends on such great ratios as saving rate, capital coefficient, capital-labour ratio, labour share, Cambridge k, etc. whose values are expected to be almost constant or to have stable trend elements in long-term historical development. The two analyses above cannot be said to be the econometric modelling works in the pure sense. Broadly speaking, however, they represent important econometric works on the economic development of Japan.

C. DEMOGRAPHIC FACTORS IN LONG-TERM MODELS

The main role of those demographic factors present in the seven long-term models discussed in the previous section, is to determine the level of the labour force. In the Klein Model, for example, population growth is endogenized together with birth and death rates. Population, then, determines the labour force to be allocated between two sectors under the full-employment assumption to attain equilibria in two product markets. In other words, labour shifts from agriculture to non-agriculture are an adjustment for equilibrium, the size of which is dependent on population growth. The same is true for the Ueno-Kinoshita Model except for the fact that labour shifts occur between three strategic sectors. In the case of the Klein-Shinkai Model without the full-employment assumption, the endogenized population determines the labour force but the labour force determines unemployment only in combination with sectoral employment to be determined by sectoral production functions. Labour shifts between the two sectors depend on wage differentials. In the Ueno Model population and labour force are both exogenous. Labour force given exogenously is allocated between two sectors under the full-employment assumption through changes in prices and wages, which are adjustment factors in the model. The Ueno Model, however, is specific in treating populations of densely inhabited areas as endogenous to be used for the explanation of public capital formation. The Minami-Ono Model is similar to the Ueno Model, introducing exogenous total employment to be allocated between two sectors through changes in prices and wages. Demographic factors are neglected almost completely in the remaining two models of effective demand type. Furthermore, the Ishiwata-Odaka Model contains private employment only to be determined by effective demand.

The role of demographic factors is thus quite limited in the long-term models of the economic development of Japan. The main role lies in the determination of the labour force, and no feed-back effects on demographic variables are allowed for except through birth rate (and sometimes death rate) as in the Klein Model, the Ueno-Kinoshita Model and the Klein-Shinkai Model. This seems natural since those long-term models are developed for research purposes to clarify the internal mechanism of historical development for which economic aspects of development are of crucial importance.

For policy purposes, however, detailed analyses of demographic factors and their interactions with purely

economic aspects become indispensible, depending on the nature of the problems to be dealt with in policy formulation. The MOSSY Model [21], which aims at the analysis of the social security system in Japan for policy purposes, is a rare and typical example of an economic-demographic model with detailed demographic specifications for the Japanese economy.

Another exceptional model has been developed by Ogawa [43]. The Ogawa Model, which is basically of the neo-classical type with some modified Keynesian features, has been designed for the analysis of the impact of population aging upon Japan's future economy over the period of 1980-2025. Although this model extensively incorporates demographic factors through such channels as labour, capital, public pension schemes and health plans, population variables have been injected into the model as exogenous ones. Furthermore, the scope of the model, which has only 22 behavioural equations, is extremely limited in terms of policy analytical purposes. Despite these shortcomings, this model is unique in explicitly quantifying the effect of population aging upon the Japanese economy, and in dealing with changes in the quality of labour force resulting from the increasing proportion of the aged population.

Chapter XI

DEMOGRAPHIC SUBMODEL

This submodel contains behavioural equations. One of the basic features of the submodel is that unlike the previous models developed in Japan, both fertility and mortality are endogenized with a certain level of elaboration and sophistication. These endogeneously-determined demographic variables are utilized in the process of population projections. Note that this submodel deals with the supply side of the labour force; the size of the labour supply is determined for each sex and age, as the product of the age-sex-specific labour force participation rate and the size of the working-age population. Most of the fertility and mortality functional relationships have been estimated from the time-series annual data for the period of 1962-1979. Labour force participation rates have been estimated on the basis of the annual data over the period of 1968-1979. The overall relationship of the variables included in the demographic submodel is depicted in Figure XI.1.

Total Fertility Rate Function

$$(1) \quad \ln (TFR - 1.70) = \underset{(15.2)}{44.24} - \underset{(-10.6)}{1.65}\, AFM_{-1} - \underset{(-3.0)}{0.00084}\, LFPR^{f2} - \underset{(-3.0)}{0.666}\, (GNPR_{-1}/POP_{-1}) - \underset{(-1.5)}{0.147}\, D1$$

$$D-W = 1.35; \bar{R}^2 = 0.964$$

Variations in the total fertility rate (TFR) are explained by the following four variables: women's age at first marriage (AFM), the labour force participation rate for women aged 25-34 ($LFPR^{f2}$), *per capita* GNP measured in 1975 million yen (GNPR/POP) and a dummy variable (D1). One can except that a rise in age at first marriage contributes, ceteris paribus, to a fall in fertility. The labour force participation of the women at reproductive ages in inversely related to fertility. *Per capita* GNP, which may reflect the general level of economic development, is negatively associated with the birth rate through changes in norms and values. The dummy variable has been included in the above equation so as to capture the irregularity of the fertility trend due to the year of the "Fire Horse" [27]. In order to avoid the possibility of TFR declining to an excessively low level, we have imposed a floor for TFR at a level of 1.7. Note that the above equation has been estimated for the 3-year moving average of observed TFRs. Figure XI.2. shows that the TFRs predicted by this equation are very close to those actually observed.

Age At First Marriage Function

$$(2) \quad AFM = \underset{(26.4)}{25.43} + \underset{(3.51)}{0.0536}\, ENROL^{f}_{-1} - \underset{(-1.84)}{2.5387}\, CRATIO_{-1}$$

$$D-W = 0.28; \bar{R}^2 = 0.462$$

As empirically shown elsewhere, the educational enrolment for women aged 15-24 ($ENROL^{f}$) positively contributes to an increase in the age at first marriage (AFM). To capture the effect of the marriage squeeze of marriageable cohorts upon the age at first marriage, we have incorporated the variable (CRATIO) representing a ratio of males aged 20-44 to females aged 15-39. The expected sign of this variable is negative; an increase in younger marriageable females relative to their male counterparts tends to raise women's overall mean age at first marriage [7].

Life Expectancy At Birth Function

Male

$$(3-1) \quad \ln [(77.4 - EM)/EM] = \underset{(-80.53)}{-1.869} - \underset{(-20.68)}{11.526}\, (SMX_{-1}/POP_{-1})$$

$$D-W = 0.72; \bar{R}^2 = 0.964$$

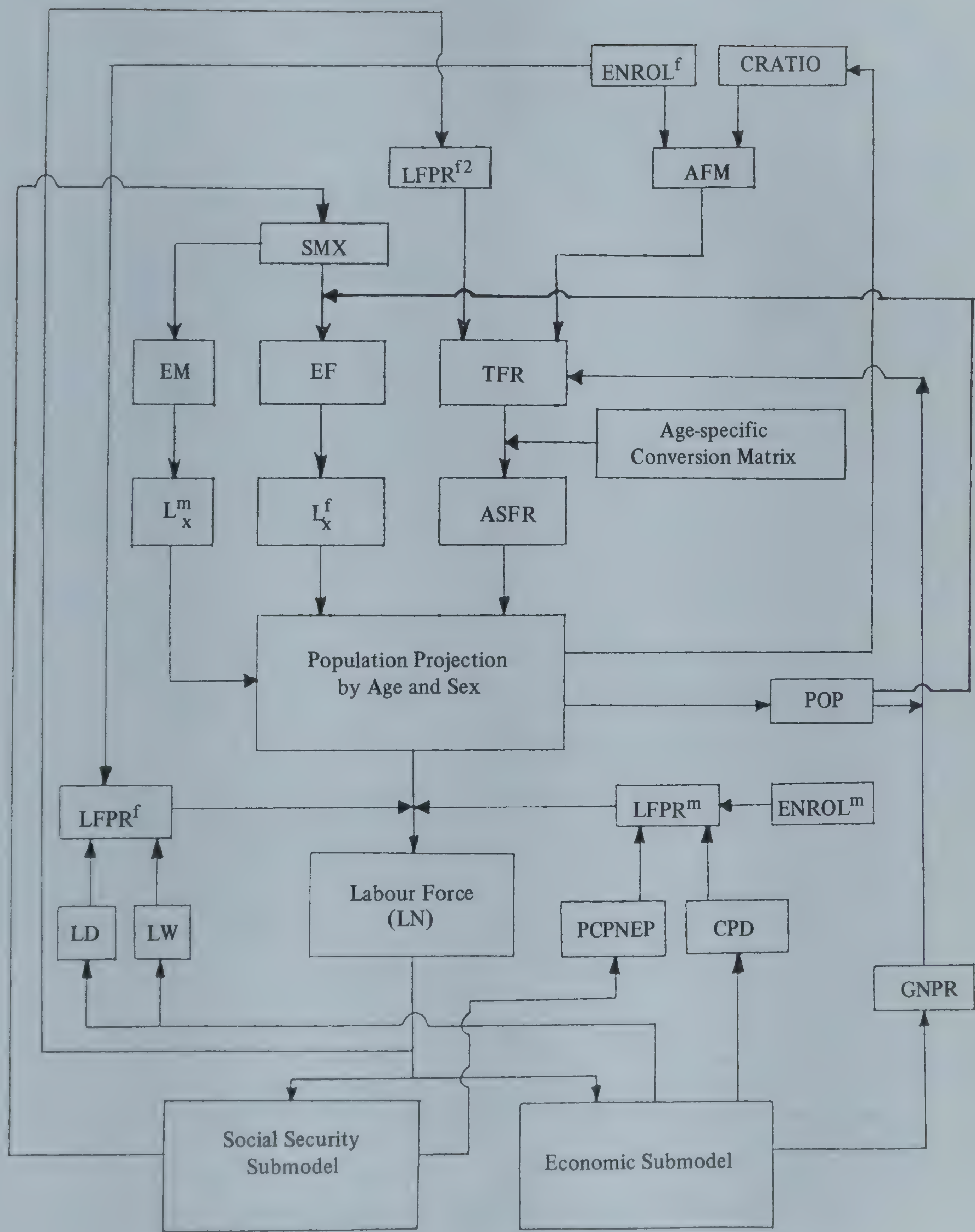


Figure XI.1. Functional relationship of the demographic submodel

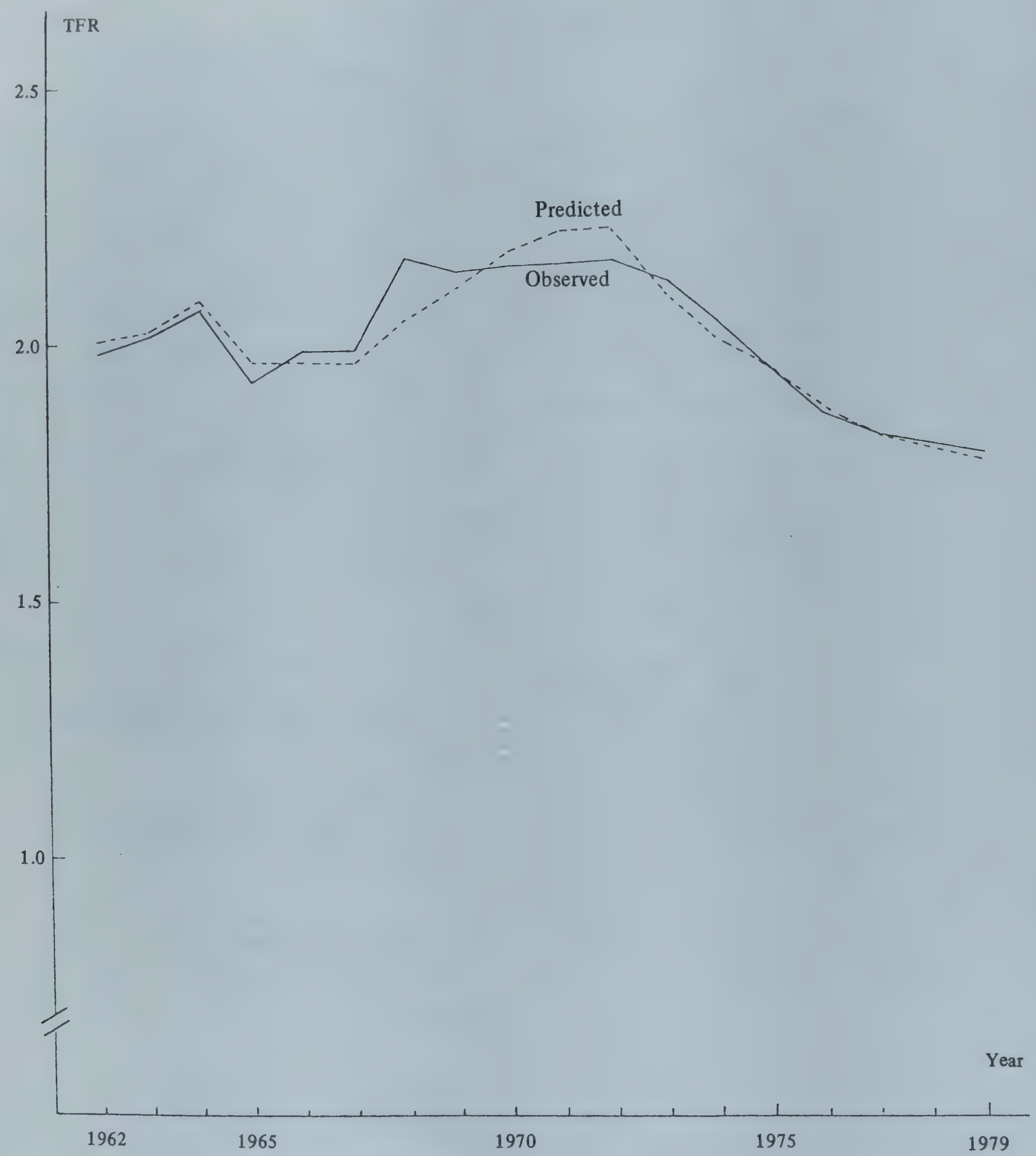


Figure XI.2. Comparison of observed and predicted TFRs, 1962-1979

Female

$$(3-2)\quad \ln[(81.7 - EF)/EF] = \underset{(-66.89)}{-2.016} \underset{(-18.76)}{-13.571} (SMX_{-1}/POP_{-1})$$

$$D\text{–}W = 0.64;\ \bar{R}^2 = 0.956$$

Both male and female life expectancy at birth, EM and EF, are positively linked to the one-year lagged per capita medical expenditure (SMX/POP). The reason for (SMX/POP) having a negative coefficient is that this equation is based on the logistic curve. The ceiling has been imposed for both sexes to keep predicted values within a realistic range. The value for the ceiling has been utilized directly from one of the hypothetical life tables which S. Hishinuma prepared in 1978 by synthesize the best age-sex-specific mortality rate in the contemporary world [9].

Age-Specific Fertility Function

$$(4)\quad -\ln\left(-\ln\left[\frac{\sum_{x=15}^{a} ASFR_{x,t}}{TFR_t}\right]\right) = 0.00034 + 0.9998\ SV_a$$

In the above equation, age-specific fertility rates (ASFRs) have been computed from the cumulated age-specific fertility values to age a, $\sum_{x=15}^{a} ASFR_{x,t}$, and a TFR estimated by Eq. 1 and a set of the standard values obtained from the data over the period of 1970-1977. The values of these weights are as follows:

Age	Standard Value
15	–2.3633
16	–2.1360
17	–1.9191
18	–1.7192
19	–1.5193
20	–1.3095
21	–1.0839
22	–0.8371
23	–0.5679
24	–0.2807
25	0.0167
26	0.3222
27	0.6353
28	0.9561
29	1.2857
30	1.6189
31	1.9535
32	2.2968
33	2.6528
34	3.0167
35	3.4026
36	3.7843
37	4.1890
38	4.6342
39	5.1112
40	5.6222
41	6.1758
42	6.8081
43	7.4813
44	8.2002
45	8.9731
46	9.7212
47	10.5190
48	11.5700
49	13.8160

The rationale for this *ad hoc* treatment is that although we have attempted to utilize either the Brass fertility estimation method or the Relational Gompertz Model of Fertility, both have shown the over-estimation of ASFRs for young age groups and the under-estimation for older age groups.

Birth Function

$$(5)\quad B_t = \sum_{a=15}^{50} \left[\frac{1}{2}\left(POPF_{a,t-1} + POPF_{a,t}\right)\right] f_{a,t}$$

where f_a denotes an age-specific fertility rate for age a, POPF, the number of women in the reproductive age span, B, the number of total births, and t, the t-th year. This technique of projecting populations corresponds to the conventional "component method". These computed births are further divided into males and females, on the basis of the sex ratio (s), as shown below:

$$B^m = \frac{s}{1+s} B$$

$$B^f = \frac{1}{1+s} B$$

The sex ratio employed for the present study is 1.06, which is identical with the one used for the 1981 government population projections [23]. The value of the sex ratio is assumed to remain unchanged in the present study.

Survival Function

Male

$$(6-1)\ L^m_{a,t} = \frac{EM_t - EM_{1980}}{\overline{EM} - EM_{1980}} \cdot (\bar{L}^m_a - L^m_{a,1980}) + L^m_{a,1980}$$

Female

$$(6-2)\ L^f_{a,t} = \frac{EF_t - EF_{1980}}{\overline{EF} - EF_{1980}} \cdot (\bar{L}^f_a - L^f_{a,1980}) + L^f_{a,1980}$$

The number of the male person-years lived between age a and a + 1 in time t, $L^m_{a,t}$, is computed by the following steps. Firstly, the value of L in Hishinuma's life table, which was computed on the basis of 5-year age grouping, has been translated to the single-year age group by applying the Beers' six-term modified formula [51]. Secondly, as expressed by the fraction of the right-hand side of the male equation above, we have computed for each age group the relative level of mortality in year t, on the basis of the computed male life expectancy at birth in year t, which is given by Eq. 3, the life expectancy at birth obtained from Hishinuma's synthesized life table, $\overline{EM}$, and that from the 1980 abridged life table, EM_{1980}. The value for $\overline{EM}$ is 77.40 years and that for EM_{1980}, 73.46 years. Thirdly, this fractional expression is used as a weight in interpolating, for each age group, the number of person-years lived derived from Hishinuma's life table, $\bar{L}^m_a$ and that from the 1980 abridged life table, $L^m_{a,1980}$. The same computational procedure has been applied to females. The value of $\overline{EF}$ is 81.70 years and 78.93 years for EF_{1980}.

Equivalent Adult Consumers

$$\begin{aligned}(7)\quad EAC = {} & 0.25 \cdot (POPMO\text{-}4 + POPFO\text{-}4) \\ & + 0.4 \cdot (POPM5\text{-}9 + POPF5\text{-}9) \\ & + 0.6\ (POPM10\text{-}14 \\ & + POPF10\text{-}14) + POPM15\text{-}100 \\ & + POPF15\text{-}100\end{aligned}$$

The total population size, which is obtained from the population projection programme, can be adjusted by a set of selected weights for different age groups with a view to capturing the effect of age-structural changes upon certain economic aspects. The weights applied in the present study are 0.25 for ages 0-4, 0.4 for ages 5-9, 0.6 for ages 10-14, and 1.0 for the remainder of the population. These weights have been used, following one of the previous studies [45]. Note that the weighted population size, which is often called "the equivalent adult consumers" (EAC), is passed to the economic submodel as one of the determinants of the level of private consumption.

Average Household Size

$$(8)\quad HS = 1.0/[\underset{(18.33)}{0.3579} + \underset{(30.38)}{0.00055}\ (GNPR_{-1}/POP_{-1})] + 2.4$$

$$D\text{–}W = 1.99;\ R^{-2} = 0.980$$

As clearly indicated in Figure XI.3. the average household size, HS, has been gradually decreasing. As in an earlier study [43], changes in HS are related to those in real GNP *per capita* (GNPR/POP). In order to keep the value of HS within the reasonable range, we have set a floor at a level of 2.4. The value of this floor reflects the lowest level being observed in contemporary industrialized countries in Western Europe [43]. The variation in HS affects the level of housing investment estimated in the economic submodel. The predicted value of HS in the past two decades is very close to the observed one, as presented in Figure XI.3.

Male Labour Force Participation Rate Function

Age Group 15-24

$$(9-1)\quad LFPR^{m1} = \underset{(53)}{0.9896} - \underset{(-24.8)}{0.012}\ ENROL^m$$

$$D\text{–}W = 1.52;\ \bar{R}^2 = 0.981$$

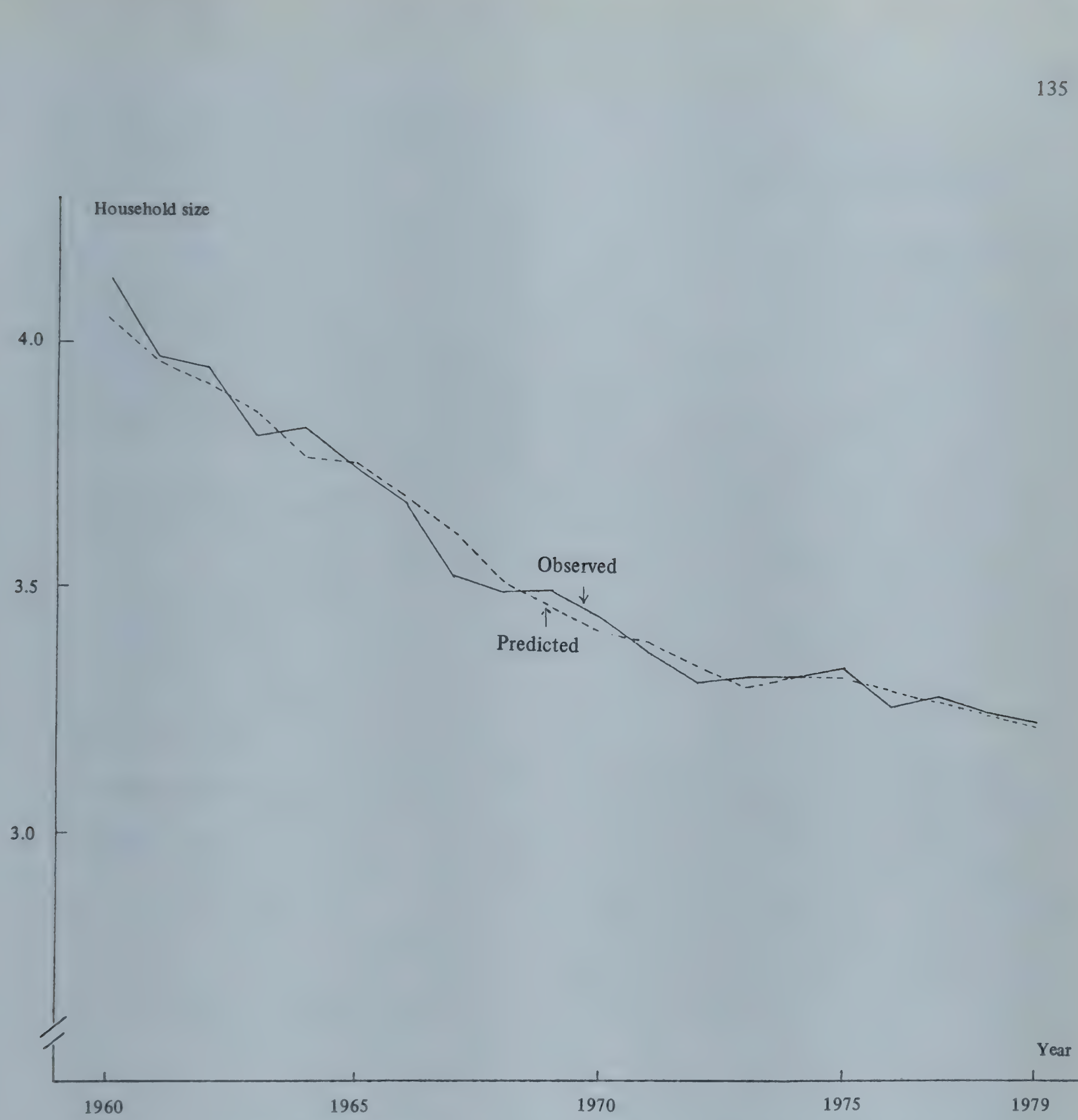


Figure XI.3. Actual and predicted values of the average household size, 1960-1979

Age Group 25-59

$$(9-2)\quad LFPR^{m2} = 0.9692$$

Age Group 60 and over

$$(9-3)\quad \ln LFPR^{m3} = \underset{(-9.72)}{-1.254} + \underset{(6.35)}{1.145} \cdot (LF^{m3}_{-1} + POPM59_{-1} \cdot LFPR^{m2}_{-1})/POPM60+_{-1} - \underset{(-2.43)}{0.000071} \cdot \frac{PCPNEP_{-1}}{CPD_{-1}}$$

$$D-W = 1.51; \bar{R}^2 = 0.982$$

The population projected on the basis of both computed mortality and fertility is then used to estimate the size of the labour force. The labour force participation rates (LFPR) for each sex have been computed for the following age groups: ages 15-24, ages 25-59, and ages 60 and over. The pattern of $LFPR^m$ observed during 1968-1979 has been depicted in Figure XI.4. For the young age group 15-24, the labour force participation rate, $LFPR^{m1}$, is determined by the level of educational enrolment for this age group, $ENROL^m$. The estimated coefficient, which has a negative sign, agrees to our a priori expection. For the age group 25-59 the labour force participation rate, $LFPR^{m2}$, is assumed to be constant at a value of 0.9692, which is the average level observed during the period of 1968-1979 [Ministry of Labour, Annual Report on the Labour Force Survey]. Judging from Figure XI.4., one can state that this assumption seems quite reasonable. For the old age group 60 and over, the labour force participation rate, $LFPR^{m3}$, is explained by two factors. One of the determinants, which is the level of the Employees' Pension Scheme benefit, PCPNEP, is expected to negatively relate to $LFPR^{m3}$. This mechanism is based upon the hypothesis that improved public pension benefits would induce earlier retirement from the labour force. $LFPR^{m3}$ is also affected by a demographic compositional change, as indicated by the first term of Eq. 9-3. This term includes the sum of the following two components: (1) the labour force size for this age group as measured in the previous year, LF^{m3}_{-1}, and (2) the number of male workers to be newly added to this age group of the labour force. The latter component is approximated by the product of the cohort size of males aged 59 in the previous year, $POPM59_{-1} \times LFPR^{m3}_{-1}$. Then, to convert the computed size of the labour force into its rate, we divide the sum by the size of the male population of this age group. One may consider that the latter factor represents the new addition to the labour force of those aged 60 and over, whereas the former, the withdrawal of this age group from the labour force. As indicated in Figure XI.4. these estimated equations can predict the a trends reasonably well.

Female Labour Force Participation Rate Function

Age Group 15-24

$$(10\text{-}1)\quad LFPR^{f1} = \underset{(0.67)}{0.2268} + \underset{(1.53)}{0.703} \cdot (LF^{f1}_{-1} + POPF14_{-1} \cdot LFPR^{f1}_{-1} - POPF24 \cdot LFPR^{f1}_{-1})/POPF15\text{-}24_{-1} - \underset{(-0.76)}{0.0029} \cdot ENROL^{f}$$

$$D-W = 1.17; \bar{R}^2 = 0.839$$

Age Group 25-44

$$(10\text{-}2)\quad LFPR^{f2} = 0.5268$$

Age Group 45-54

$$(10\text{-}3)\quad LFPR^{f3} = 0.6062$$

Age Group 55 and over

$$(10\text{-}4)\quad LFPR^{f4} = \underset{(1.30)}{0.0248} + \underset{(6.62)}{0.7263} \cdot (LF^{f4}_{-1} + POPF54_{-1} \cdot LFPR^{f3}_{-1})/POPF58+_{-1} + \underset{(1.91)}{0.1296} \cdot \frac{LD_{-1} - LW_{-1}}{LD_{-1}}$$

$$D-W = 1.92; \bar{R}^2 = 0.977$$

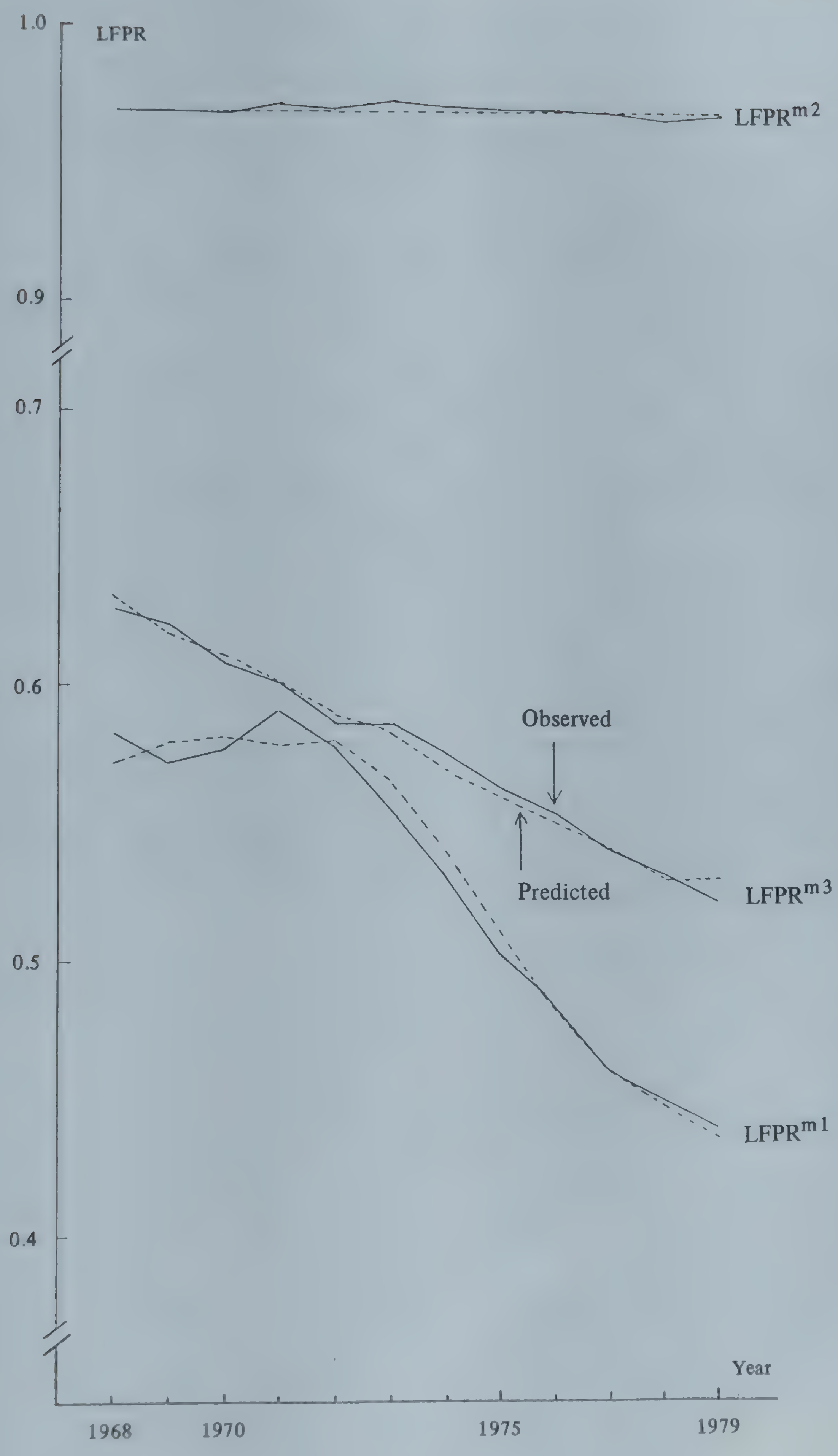


Figure XI.4. Actual and predicted values of male labour force participation rates for various age groups

We have classified the female working age population into the following four age groups: 15-24, 25-44, 45-54, and 55 and over. The past trend of $LFPR^f$ each age group has been presented in Figure XI.5. For ages 15-24, the labour force participation rate, $LFPR^{f1}$, is related to changes in demographic factors, as expressed by the first term of the right-handed side of Eq. 8-1, and the female educational enrolment rate for this age group, $ENROL^f$, which corresponds to the second term of the same equation. The rationale for the inclusion of these variables in the equation is quite comparable to that of Eq. 9-3 which we have considered in the above. For the age group 25-44, the labour force participation rate ($LFPR^{f2}$) is assumed to remain unchanged at a level of 0.5268. Because no pronounced variation in $LFPR^{f2}$ can be detected over the sample period (1968-1979), as shown in Figure XI.5. this assumption seems quite valid. For the age group 45-54, the labour force participation rate ($LFPR^{f3}$) is also assumed to be constant at a rate of 0.6062. Just as in the case of $LFPR^{f2}$, no obvious pattern could be observed over the period of 1968-1979. For those aged 55 and over, the labour force participation rate ($LFPR^{f4}$) is subject to changes in demographic factors, as represented by the second term of the right-handed side of Eq. 10-4, and in the proportion of those with self-employed status to a total of those engaged in productive activities [(LE-LW)/LD]. One should recall that the reason for Japan having an exceptionally high labour participation level of the aged persons (as compared to other industrialized countries), is that most of the female workers in this age group have this employment status. Henceforth, changes in [(LD-LW)/LD] considerably affect the level of $LFPR^{f4}$. Note that the value of [(LD-LW)/LD], which is lagged by one year, is derived from the economic submodel. As compared with male LFPRs, those for females show a fairly poor fit, which probably reflects the possibility that the latter tends to be more complexly interated with socio-economic development factors.

Total Labour Supply

$$
\begin{aligned}
(11) \quad LN = \; & LFPR^{m1} \cdot POPM15\text{-}24 \\
& + LFPR^{m2} \cdot POPM25\text{-}54 \\
& + LFPR^{m3} \cdot POPM55+ \\
& + LFPR^{f1} \cdot POPF15\text{-}24 \\
& + LFPR^{f2} \cdot POPF25\text{-}44 \\
& + LFPR^{f3} \cdot POPF45\text{-}54 \\
& + LFPR^{f4} \cdot POPF55+
\end{aligned}
$$

The total supply of labour, LN, is the sum of the product of an age-sex-specific LFPR and the size of the corresponding population for the seven groups. The amount of effective labour is determined in the economic submodel, after allowing for the level of unemployment.

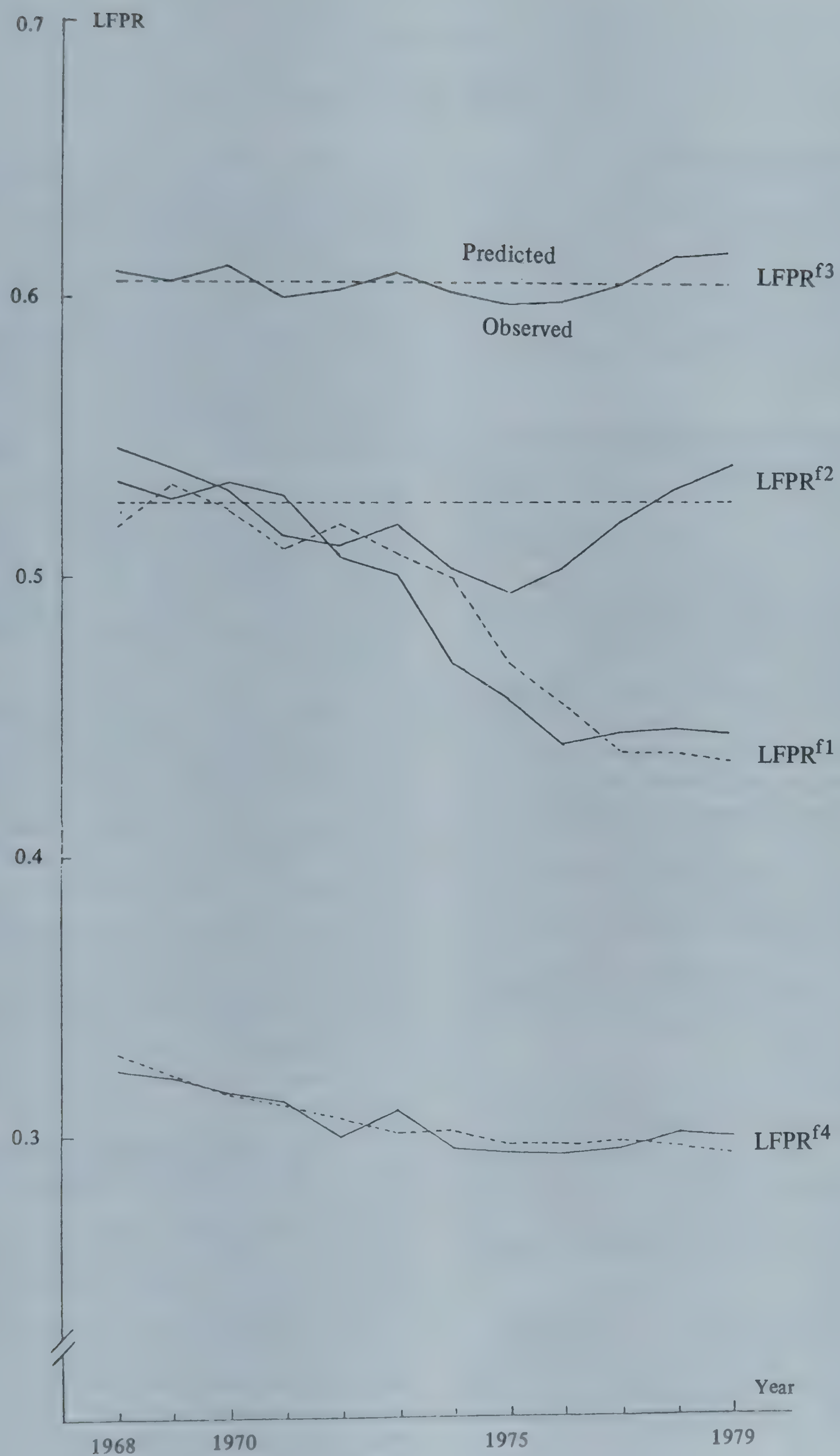


Figure XI.5. Actual and predicted values of female labour force participation rates for various age groups

Chapter XII

ECONOMIC SUBMODEL

A. OVERVIEW

This economic submodel is basically of a long-run, supply-oriented nature. Although adjustment mechanisms between demand and supply are very important in a short-run forecasting model, in long-run models, it is supply-oriented factors such as capital stock and labour force, that tend to determine economic growth paths.

Because in the present model, the labour supply is determined in the demographic submodel, the main task of the economic submodel is to determine a level of both savings and capital formation, which in turn, determine the level of production. The production function allows for substitution between capital and labour. Moreover, the vintage of capital stock is included to capture the effect of technological progress.

As regards capital formation, private fixed capital investment is determined by both total private savings and the growth rate of real GNP, the latter being a proxy of business expectations with respect to the long-run growth of the demand components. Note that the major portion of total private savings consists of personal savings, which have been the principal source of private fixed capital investment mediated through commercial banks in the past few decades. Furthermore, the investment propensity of the business sector, which has been very high when compared with other industrialized countries, has played a critical role in boosting the postwar Japanese economy.

Besides providing personal savings, the household sector has the function of supplying labour. In the present model, the demographic submodel computes labour force participation rates and the size of the labour force, both of which, in turn, are used in the economic submodel to determine the level of employment and the number of hours worked.

Another key variable in the labour market is the level of wages. The wage function incorporates the expanded Phillips curve hypothesis which is represented by consumer prices, labour productivity and unemployment.

Moreover, price deflators are determined by the unit labour cost which contains wage, employer's contribution to the social security system, labour productivity, and exogenous import prices.

The economic submodel feeds wages levels, consumer prices, and the number of employees into the social security submodel. Based upon these variables, the social security submodel computes the level of contributions and benefits in various social security programmes. It should be noted, however, that several variables of the social security submodel affect those of the economic submodel. For instance, an increase in social security benefits contribute to a greater disposable income of the aged population, and to a lesser disposable income of the younger generation resulting from an increase in contributions to the social security system. The net effect of such transfers through the social security system on aggregate personal disposable income depends on the demographic structure and the structure of the social security system. Changes in aggregate disposable income affect aggregate personal consumption.

Another link from the social security system to the economic submodel involves the business sector. In line with the increase in the employer's contribution to the social security system, the unit labour cost rises and the corporate profit diminishes, holding everything else constant. The improvement of the social security system adds pressure to reduce corporate income as well as future business investments. Consequently, the improvement of social security benefits affects the final demands in the short run such as personal consumption and business investment, and in the long run, the capacity of production.

B. ROLES OF HOUSEHOLD AND BUSINESS SECTORS

In this economic submodel, the household sector consumes goods and services, contributes to residential investment, and supplies labour. Personal consumption consists of the following two components. One of them is the consumption of ordinary goods and services (C1), and the other, the consumption of medical goods and services (C2). One of the determinants of C1 is adjusted disposable income (YDD) which consists of the disposable income (YD) with government cash benefits through social security programmes (GNKTR) added and with both government income transfers (TR) and personal payments of medical goods and services (SMX-SMTR) subtracted. The other determinants of the

function for C1 include the following two household-level "psychological variables" of the economic environment: unemployment and inflation rates. Household savings are defined as the difference between the disposable income and total personal consumption.

Although in the short run, housing investment fluctuates in accordance with changes in such variables as the price of residential stock price, income and the interest rate, in the long run, the residential stock can be assumed to meet the needs of the people. In the present model, the newly-constructed residential stock is obtained as the sum of replacements plus a net increase of the number of households. The amount of housing investment is computed as the product of the newly constructed residential stock and the unit construction cost.

While the maximum amount of labour supply is determined in the demographic submodel, the hours worked are determined in this economic submodel. Generally speaking, in developed countries, the number of hours worked show a declining trend as a result of the growth of real hourly wage rate. In Japan the hours worked decreased rapidly particularly in the period of high economic growth. In spite of this, the hours worked are still considerably greater than those for other developed countries. Hence, the declining trend of the hours worked appear to continue in the years to come. The diminishing hours worked would decrease the total supply of labour if the number of workers remains unchanged.

In the business sector, both production (GNP) and business investment are key variables. Given their long-run expectations for demand and technological progress, business firms select the proper combination of capital and labour to maximize their profits. Fixed capital investment is determined by the expectation of the growth of total demand and total private savings. This arises because GNP in real terms is supply determined; the sum of expenditure on GNP may therefore exceed or fall short GNP. The equality of investment and savings is not assured for each time period. In fact, it often happens that investment is smaller than savings. In the present model, however, the demand-supply adjustment mechanism mediated through price changes is not explicitly incorporated. Rather, the imbalance of investment and savings is adjusted through other mechanisms. To keep the investment-savings balance, the I-S gap is redistributed to each item of the three demand components on the basis of their proportions.

Although the price mechanism is not included in the present model, the determination of prices is still needed for the following three reasons. One is that the price level is needed for both consumption and labour demand functions. The second reason is that the price level is required to link nominal terms to real terms in the economic submodel. The third reason is that it is called for by the social security submodel.

The mechanism of determination is based on the expanded Phillips curve hypothesis which includes such variables as consumer prices, labour productivity and the unemployment rate. Note that consumer price or consumption deflator is determined by the unit labour cost, labour productivity and the price level of imported goods. Other deflators are determined mainly by the unit labour cost and labour productivity.

C. STRUCTURE OF THE ECONOMIC SUBMODEL

Production Function

In any long-run economic model the way in which the contribution of technological progress is treated is extremely important. The following formulation is often used to represent a neo-classical production function:

$$GNPR = A \, . \, \lambda^{et} \, (KP \, . \, \rho)^{\alpha} \, . \, (LD \, . \, h)^{\beta}$$

GNPR:	real GNP
KP:	capital stock
ρ:	utilization rate of capital equipment
LD:	labour force
h:	hours worked *per capita*
λ:	contribution of technological progress
t:	time trend
α, β:	parameter

In this formulation, however, technological progress is determined only by a time trend factor rather than by changes in the quality of labour and capital equipment. Because the contribution of technological progress rapidly increased during the period of high economic growth in Japan, the value of λ estimated on the basis of time-series data would be too high for long-run simulation. To avoid this upward bias, we have adopted the vintage of capital stock as a proxy of technological progress, as shown below:

$$\lambda(t) = \left(\sum_{t=1}^{T} IPR_{-t}\right) / KP_{-1}$$

where IPR denotes the amount of fixed business investment in real terms, and T represents the Tth year. In this specification it is assumed that the newly-constructed equipment has a higher productivity than the old one.

The estimated result is as follows:

$$\ln\left(\frac{GNPR}{LD \cdot h} \cdot 100\right) = \underset{(-24.07)}{-2.553} + \underset{(67.61)}{0.734} \cdot \ln\left(\frac{KP_{-1} \cdot \bar{\rho}}{L \cdot h} \cdot 100\right)$$

$$+ \underset{(6.59)}{0.2721} \cdot \ln\left(\frac{\sum_{t=1}^{4} IPR_{-t}}{KP_{-1}}\right)$$

$$D\text{–}W = 1.59; \bar{R}^2 = 0.998$$

Corporate income

$$\ln YC = \underset{(-8.66)}{-8.216} + \underset{(8.31)}{4.873} \cdot \ln(GNPN - TI)$$

$$\underset{(-6.63)}{-3.563} \cdot \ln(YW + SIE)$$

$$D\text{–}W = 1.03; \bar{R}^2 = 0.982$$

Corporate income (YC) is a function of the net value added (GNPN-TI) and the total labour cost which includes wages (YW) and employers' contributions to various social insurance schemes (SIE).

Retained Corporate Income

$$SC = YC - TC - DIV$$

Retained corporate income (SC) is defined as a remainder of corporate income after deducting corporate taxes (TC) and dividends (DIV).

Fixed Business Investment

$$\ln IPR = \underset{(2.09)}{-0.7625} + \underset{(26.50)}{0.8641} \cdot \ln \sum_{t=1}^{3} \left(\frac{SP + SC + DEP}{3 \cdot IPD} \cdot 100\right)_{-t}$$

$$+ \underset{(3.61)}{3.319} \cdot \ln\left(\frac{GNPR}{GNPR_{-1}}\right)_{-1}$$

$$D\text{–}W = 1.42; \bar{R}^2 = 0.976$$

where SP stands for personal savings and DEP is the capital consumption allowance. The first term of the above equation represents total private savings in real terms, which, as previously mentioned, include not only corporate savings (SC) and depreciation (DEP) but also private savings. The second term is the growth rate of demand in the preceding year, which is a proxy of corporate's expectations with regard to future changes in demand.

In the short-term model, the rate of interest is important. In the long-run model, in contrast, the potential of investment which is proxied by variables, such as savings and changes in demand, is more essential. Furthermore, to build a simple-structured model, we have excluded the interest rate from the ultimate specification of the equation.

Changes in age structure of population or in the social security system affect the level of the contribution to the social security system. If the employer's contribution increases, ceteris paribus, both corporate income and savings fall, and consequently business investment declines.

Productive Capital Stock

$$KP = KP_{-1}\,(1.0 - \theta) + IPR$$

where θ represents the proportion of capital consumption to total capital stock, and it is an exogenous variable. The observed value of θ for 1979 was 0.0539 and the average value of θs from 1962 to 1979 is 0.05, as shown in the Non-residential Business Capital Stock recently published by the Economic Research Institute of the Economic Planning Agency. Because these observed values appear to be too high for purposes of simulation, θ required adjustment (see Chapter VI).

Personal Consumption Function

In order to maintain a consistency between personal consumption and government transfers to the household sector, we have divided personal consumption

(CP) into two components. One of them is the consumption of ordinary goods and services (C1), and the other is the consumption of medical goods and services (C2).

The consumption of medical goods and services included in the *System of National Accounts* consists of two factors; the medical benefits in kind provided through medical insurance and other programmes, and payments by patients. The nominal value of C2 is computed by the following equation which has as an explanatory variable, the aggregate medical cost (AMX) from the social security submodel:

$$\underset{}{C2N} = \underset{(6.51)}{269.86} + \underset{(135.5)}{1.253} \cdot AMX$$

$$D-W = 1.71; \bar{R}^2 = 0.999$$

On the other hand, the consumption of ordinary goods and services is determined as follows:

$$\left(\frac{C1R}{EAC} \cdot 100\right) = \underset{(13.6)}{97.62} + \underset{(62.5)}{0.7621} \cdot \left(\frac{YDD - GNKTR}{C1D \cdot EAC} \cdot 10000\right)$$

$$+ 1.0 \cdot \left(\frac{GNKTR \cdot 10000}{C1D \cdot EAC}\right)$$

$$- \underset{(-8.04)}{3.639} \cdot \left(\frac{\triangle C1D}{C1D_{-1}} \cdot 100\right)$$

$$- \underset{(-5.29)}{34.92} \cdot \left(\frac{UN}{LN} \cdot 100\right)$$

$$D-W = 1.77; \bar{R}^2 = 0.999$$

where C1R = consumption of ordinary goods and services (in real terms),

EAC = total population adjusted by equivalent consumer units,

YDD = adjusted disposable income,

CPD = personal consumption deflator,

UN = unemployment,

LN = labour force, and

GNKTR = cash transfered benefits.

The second and third terms are the variables capturing the income effect. The other terms represent consumers' expectations in response to changes in the economic environment.

Disposable income has been modified along the following lines. Government transfers to the household (TR) include (i) cash payments through public pension and other social security programmes, (ii) the supply of medical goods and services in kind, and (iii) the supply of non-medical benefits in kind. If TR is used as an explanatory variable for the personal consumption of ordinary goods and services (C1), an increase in the supply of medical benefits in kind leads to an increase in C1. This effect is unlikely and to avoid it, we separated from total private consumption (CP) a medically-related part of consumption (C2), which in turn is explained by the aggregate medical cost (SMX). Hence, a rise in aggregate medical benefits (SMX) leads to a higher level of total private consumption (CP), mediated through an expansion of C2. Furthermore, we have added the transfered cash benefits (GNKTR) and subtracted the government transfer to households (TR), to obtain the modified disposable income. This implies that an increase in the transfered cash benefits (GNKTR) C1 is mediated through an increase in YDD. One more component of the adjusted personal disposable income is the patients' payment which corresponds to the difference between SMX and SMTR. Because the increase in this component depresses a level of the personal consumption of ordinary goods and services, we have subtracted this component from YD to obtain YDD. As a result, the adjusted personal disposable income is denoted as follows:

$$YDD = YD - TR + GNKTR - (SMX - SMTR)$$

In addition, in order to reduce the number of variables, rather than estimate the consumption function for each age group, we used the total population adjusted by adult equivalent consumer units (EAC).

The next point is related to the effect of changes in social security variables upon the economic submodel. It should be noted that the main part of total disposable income excluding the transfered cash benefit (YDD-GNKTR) is the earned income of the working generation and that the main part of the cash benefit (GNKTR) consists of pension payments for the aged population.

The improvement of social security benefits increase the disposable income of the aged. At the same time, an increase in contributions to the social security system results in the reduction of the disposable income

of the younger generation. Also note that the propensity to consume is different between these age groups. Based on such consideration, the income related effects could be represented by the ordinary income term (YDD-GNKTR) as well as the cash benefits income term (GNKTR). The value of the coefficient for the ordinary income term is smaller than that for the cash benefit term. This supports the hypothesis that the marginal propensity to consume for the working age population is lower than that for the aged population. This result leads to the conclusion that even if an increase in benefits is accompanied by an equal rise in the contributions, the net effect would be the increase in total consumption.

It is often argued that the level of personal consumption is affected by changes in social security programmes through the "life-cycle" mechanism. According to this theory, a downward effect of social security programmes on personal savings could be expected (see [6]). The individual views expected social security benefits during retirement as a substitute for his own pre-retirement savings and is therefore motivated to diminish the accumulation of assets during his working years. This conclusion suggests that an improvement in social security provisions will increase the consumption of younger generations. In contrast, opposing arguments have been advanced by a few other economists. For instance, Cagan, drawing upon a "recognition effect", asserts that social security programmes make each young individual more "security-conscious", thus stimulating personal savings. These arguments imply that age-structural changes might affect the level of aggregate personal savings through these lifetime savings cycle effects. We attempted to capture these effects by incorporating changes in the mean age of the male population above age 25, but preliminary results indicated that it is statistically insignificant. For this reason, the variable has been eliminated from the ultimate specification of the equation. The third and fourth terms represent a psychological (or expectational) effect.

After the inflation resulting from the first oil crisis in 1974, we observed the downward shift of the propensity to consume. Subsequently, the traditional consumption function has failed to explain the pattern actually observed. In some of the recent econometric models, efforts have been made to explain changes in personal consumption over the post-petrocrisis period, by introducing various hypotheses. For example, the consumption function of the model developed by the Japan Economic Research Center includes the asset effect, as shown below:

$$CP = 3716 + \underset{(7.3)}{0.596} \cdot YD/CPD + \underset{(1.6)}{0.083}\ (FI_{-1}/CPD)$$

$$D{-}W = 0.289;\ \bar{R}^2 = 0.995$$

where FI = personal monetary assets, and

CPD = consumption deflator.

Another example is based on the model developed by the Committee for Econometric Model Analysis (CEMA). Its consumption function is expressed as follows:

$$CP = 0.2179 \cdot 10^7\ 0.2850\ YD/CPD + 0.2475\ CP_{-1} + 0.6422 \cdot 10^{-1}\ (FI_{-1}/CPD + KHN_{-1}/IHD)$$

$$D{-}W = 0.16;\ \bar{R}^2 = 0.998$$

where KHN = residential stock, and

IHD = housing investment deflator.

The other variable which has recently received increasing attention concerns expectations. For instance, the CEMA model contains an inflation term as an expectation variable [16].

$$CP = 0.4303 \cdot 10^6 + \underset{(49.2)}{0.3398} \cdot YD/CPD + \underset{(55.0)}{0.5722} \cdot CP_{-1} - \underset{(9.2)}{0.2920} \cdot 10^{-2} \cdot (CPD - ECPD) \cdot YD/CPD$$

where CPD = rate of increase of the consumption deflator

$$ECPD = 1/3 \sum_{t=1}^{3} CPD_{-t}$$

In the 1977 White Paper on the Japanese Economy, an indicator measuring the degree of economic uncertainty for the household sector was

introduced into the consumption function. This indicator consists of the combination of both unemployment and inflation rates.

Komine and Nishiyama [30] estimated the expected income from the data of a consumer survey and introduced it into the consumption function, as shown below.

$$CP = \underset{}{5416} + \underset{(5.1)}{0.317}\ YD/CPD + \underset{(2.4)}{0.238}$$

$$\cdot\ \mu^t \cdot YD/CPD + \underset{(4.9)}{0.480}\ CP_{-1}$$

$$D\text{–}W = 1.99;\ \bar{R}^2 = 0.992$$

where μ^t = growth rate of expected income.

Although all of these empirical results are worth considering, to keep the present model manageable, we have included in the consumption function of our model the unemployment rate and growth rate of consumer prices as proxies of consumers' expectation.

When the unemployment rate rises, households feel more discouraged about future employment prospects and income growth, and therefore the effect of income on consumption will be lessened due to psychological factors.

To determine the level of housing investment, the number of newly-constructed housing units is calculated on the basis of the following procedure. First, the number of households can be computed by dividing the total population by the average size of the household.

$$HLD = POP/HS$$

where POP = total population, HLD = number of the households, and

HS = average size of the household. (Note that both POP and HS are derived from the population submodel).

Newly constructed housing units can be defined as the replacement of residential stock (REP) and the new demand arising from the net increase of the number of households ($\triangle$HLD).

$$HOUI = \overline{REP} \cdot HLD_{-1} + \triangle HLD$$

where HOUI = number of newly constructed residential units, and REP = replacement rate.

One can then define the level of private housing investment as the number of newly constructed residential units multiplied by the unit cost for construction, as expressed below:

$$IHR = \overline{RCOST} \cdot HOUI$$

where IHR = private housing investment, and RCOST = unit cost for construction.

For simplicity's sake, both government consumption expenditures and government investment in nominal terms are defined as a certain proportion of nominal GNP.

$$CGN = \bar{\gamma} \cdot GNPN$$

$$IGN = \phi \cdot GNPN$$

where CGN = government consumption expenditure in nominal terms, IGN = fixed government investment in nominal terms, and γ and ϕ = exogenously determined parameters.

Another demand component is the trade balance. To simplify the model, one can assume the surplus of the current account to be a certain proportion of real GNP (ALPHA). The functional expression for this relation is as follows:

$$EXR - IMR = \overline{ALPHA} \cdot GNPR$$

where ALPHA = parameter.

The private sector inventory investment (JPR) is determined by the difference between the desired level of inventory stock for this year and actual level of inventory stock for the previous year. The desired level of inventory stock for this year (KJPR) is directly related to that of real GNP. The estimated results for these two functions can be expressed as below:

$$\ln JPR = \underset{(2.59)}{2.136} + \underset{(6.43)}{0.7130}$$

$$\ln (KJPR - KJPR_{-1})$$

$$D\text{–}W = 2.51;\ \bar{R}^2 = 0.704$$

$$\ln KJPR = \underset{(-11.6)}{-3.114} + \underset{(49.86)}{1.152}\ \ln GNPR$$

$$D\text{–}W = 0.55;\ \bar{R}^2 = 0.993$$

To maintain the equality between demand and supply, we make proportional adjustments of the demand-supply gap by reallocating the gap among the following three demand elements: CGR, IGR and IHR. One should note that there are many other ways to adjust the gap. For instance, the gap could be adjusted through inventories (JPR), or the tarade balance (EXR-IMR). Preliminary analyses have shown, however, that adjustments through these demand components lead to extremely unrealistic results. For this reason, we have adopted the gap adjustment through the above three demand elements.

In this model labour supply is determined by two factors. One is the set of labour force participation rates for various age groups, derived from the population submodel, and the other is related to hours worked. In the short-run, employers tend to determine, how long their employees should work, based upon the production level. But in the long-run context, workers contribute to the determination of hours worked, on the basis of level of income as well as the utility of leisure. This relationship might be expressed as the elasticity of hours worked (h) to the real wage (WAGE/CPD) per hour, as follows:

$$h \quad = \quad f\left(\frac{WAGE/CPD}{h}\right).$$

The estimated equation is

$$\underset{}{\ln h} \quad = \quad \underset{(78.4)}{5.664} - \underset{(-13.6)}{0.1339} \cdot \ln (WAGE/CPD)$$

$$D\text{–}W = 0.83; \bar{R}^2 = 0.916$$

In this estimated equation, if the level of real wage rate increases, workers prefer to have a greater amount of leisure time and to decrease the quantity of labour supply by shortening hours worked.

Labour demand (LD) is determined by the following two factors: the level of actual output and the relative price of labour force.

$$LD \quad = \quad f\left(GNPR, \frac{WAGE}{GNPD}\right).$$

Furthermore, unemployment is defined as the difference between labour demand and supply. This yields:

$$UN \quad = \quad LN - LD$$

where LN = labour supply (labour force), LD = labour demand (persons employed), and UN = unemployment.

Although this formulation on the labour side has been attempt, in the simulation process the amount of unemployment fluctuates enormously, thus contributing to the instability of the model. Hence, the following alternative formulation has been used in the present study. First of all, the level of unemployment has been obtained. Mathematically, unemployment can be expressed as follows:

$$UN \quad = \quad LN - f\left(GNPR, \frac{WAGE}{GNPD}\right)$$

The estimated result is as follows:

$$\ln UN = \underset{(-1.51)}{-52.781} + \underset{(1.59)}{8.393} \ln LN$$

$$\underset{(-1.83)}{-3.033} \ln GNPR$$

$$\underset{(2.56)}{+2.832} \ln \left(\frac{WAGE}{GNPD}\right)$$

$$D\text{–}W = 1.70; \bar{R}^2 = 0.848$$

Subsequently, labour demand has been computed as the difference between labour supply and unemployment.

$$LD \quad = \quad LN - UN$$

The wage rate (WAGE) is defined as the employee's average income excluding the employer's contribution to various social security programmes. In the present model, the wage rate is determined on the basis of the expanded "Phillips curve" function.

$$\left(\frac{\Delta WAGE}{WAGE_{-1}} \cdot 100\right) = \underset{(3.37)}{10.883} + \underset{(8.39)}{0.9636}$$

$$\cdot \left(\frac{\Delta CPD}{CPD} \cdot 100\right)$$

$$+ \underset{(1.77)}{0.2248} \left[\frac{\Delta(GNPR/LD)}{(GNPR/LD)_{-1}}\right.$$

$$\left.\cdot 100\right] - \underset{(-3.45)}{4.062}$$

$$\cdot (UN/LN \cdot 100)$$

$$D\text{–}W = 0.92; \bar{R}^2 = 0.899$$

The first term of the equation represents the rate of inflation, the second term, the growth rate of labour productivity, and the third term, the unemployment rate. These three terms reflect the theoretical consideration involved in the expanded version of the Phillip curve hypothesis [47].

By following the conventional method of computing deflators, we have included in the deflator equation the unit labour cost, $(\frac{YW + SIE}{LW})$, labour productivity $(\frac{GNPR}{LD})$, and prices of imported goods (MD). Empirically, we have obtained the following result:

$$\begin{aligned}
\ln CPD = \; & \underset{(0.54)}{0.384} + \underset{(8.80)}{0.7215} \cdot \ln \left(\frac{YW + SIE}{LW} \cdot 10000\right) \\
& - \underset{(-3.34)}{0.3782} \cdot \ln \left(\frac{GNPR}{LD} \cdot 10000\right) \\
& + \underset{(0.36)}{0.0248} \cdot \ln \left(\overline{MD} / 100\right)
\end{aligned}$$

$$D\text{–}W = 0.30; \; \bar{R}^2 = 0.998$$

In the above we have discussed theoretical reasoning behind some of the equations included in the economic submodel. In the next section, we list the complete set of economic submodel equations to be used for simulation experiments.

D. SYSTEM OF THE EQUATIONS

All the behavioural equations incorporated in the economic submodel have been estimated on the basis of annual data over the period of 1962-1979. Just as in the case of the population submodel, the method of estimation employed was ordinary least squares and the figures recorded beneath the estimated coefficients are t-statistics. To facilitate the understanding of the interrelationship of all the equations, the schematic chart of the economic system has been prepared in Figure XII.1.

Notation

Endogenous Variables

GNPR	gross national product (billions of 1975 yen)
GNPN	gross national product in nominal term (billion yen)
YD	disposable income (billion yen)
YDD	adjusted disposable income (billion yen)
YC	corporate income (billion yen)
DIV	corporate dividends (billion yen)
YW	employees' income (billion yen)
TAX	total taxes (billion yen)
TP	personal tax (billion yen)
TC	corporate tax (billion yen)
TI	indirect tax (billion yen)
LD	employment (thousand persons)
LW	number of employees (thousand persons)
LN	labour force (thousand persons)
h	hours worked (1975 = 100)
UN	unemployment (thousand persons)
WAGE	wage rate (ten yen)
C1R	private consumption of ordinary goods and services (trilions of 1975 yen)
C2N	private consumption of medical goods and services in nominal terms (billion yen)
CPR	private consumption (billions of 1975 yen)
CPN	private consumption in nominal term (billion yen)
IHR	private housing investment (billions of 1975 yen)
IPR	private fixed investment (billions of 1975 yen)
CGR	consumption expenditure by government (billions of 1975 yen)
CGN	consumption expenditure by government in nominal term (billion yen)
IGR	fixed capital investment by government (billions of 1975 yen)
IGN	fixed capital investment by government (billions of 1975 yen)
JPR	private inventory investment (billions of 1975 yen)
KJPR	desired inventory stock (billions of 1975 yen)
EXR	Export (billions of 1975 yen)
IMR	Import (billions of 1975 yen)

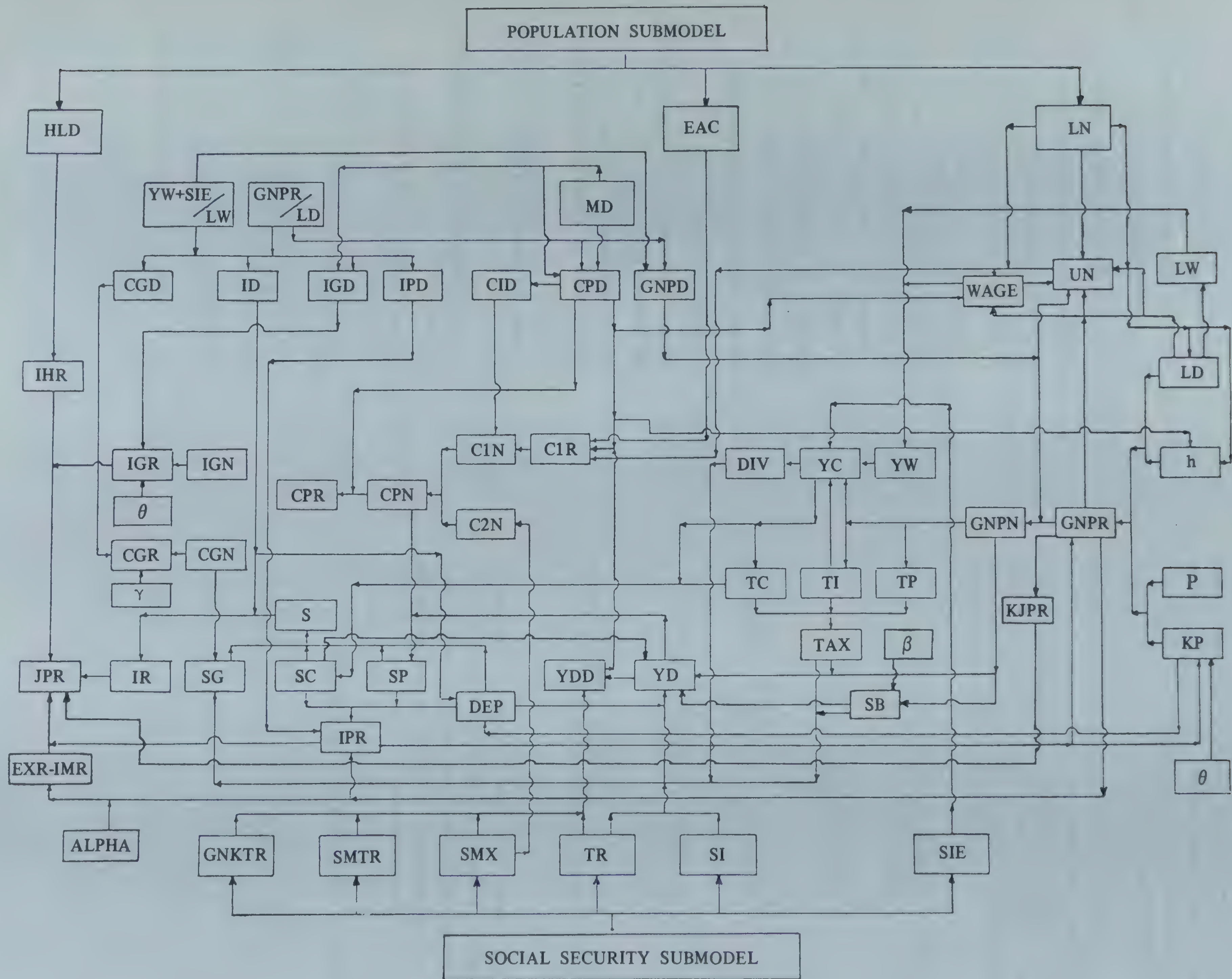


Figure XII.1. Schematic chart of the economic submodel

KP	productive capital stock (billions of 1975 yen)
DEP	capital consumption allowance (billions of 1975 yen)
CPD	personal consumption deflator (1975 = 100)
C1D	deflator of personal consumption of ordinary goods and services (1975 = 100)
IPD	private fixed investment deflator (1975 = 100)
CGD	government consumption expenditure deflator (1975 = 100)
IGD	government fixed investment deflator (1975 = 100)
ID	total fixed investment deflator (1975 = 100)
GNPD	GNP deflator (1975 = 100)
TR	government transfer to households (billion yen)
GNKTR	cash benefits paid out by government (billion yen)
SI	contribution to the social security system (billion yen)
SIE	employer's contribution to the social security system (billion yen)
SMX	aggregate medical cost (billion yen)
SMTR	aggregate medical benefit in kind (billion yen)
SB	government subsidies (billion yen)

Exogenous variables

θ	capital consumption
γ	proportion of CGN to GNPN
ϕ	proportion of IGN to GNPN
MD	import deflator (1975 = 100)
ALPHA	proportion of surplus of current account to real GNP
ρ	capacity utilization rate (1975 = 100)
β	proportion of SB to GNPN
REP	replacement rate in housing stock
RCOST	unit cost of housing investment (billions of 1975 yen)

1. Production and Income Distribution

(1) Total Output

$$\ln\left(\frac{GNPR}{LD \cdot h} \cdot 100\right) = \underset{(-24.7)}{-2.553} + \underset{(67.61)}{0.734} \cdot \ln\left(\frac{KP_{-1} \cdot \bar{\rho}}{LD \cdot h} \cdot 100\right) + \underset{(6.59)}{0.2721} \ln\left(\frac{\sum_{t}^{4} IPR_{-t}}{KP_{-1}}\right)$$

$D\text{–}W = 1.59;\ \bar{R}^2 = 0.998$

(2) Corporate income

$$\ln YC = \underset{(-8.66)}{-8.216} + \underset{(8.31)}{4.873} \cdot \ln(GNPR - TI) \underset{(-6.63)}{-3.563} \cdot \ln(YW + SIE)$$

$D\text{–}W = 1.03;\ \bar{R}^2\ 0.982$

(3) Corporate dividend

$$\ln DIV = \underset{(-3.24)}{-0.925} + \underset{(26.50)}{0.9042} \cdot \ln YC$$

$D\text{–}W = 0.68;\ \bar{R}^2 = 0.967$

(4) Employees' income

$$YW = WAGE \cdot LW/10000$$

(5) Total taxes

$$TAX = TP + TC + TI$$

(6) Personal income tax

$$TP = \underset{(-4.63)}{-519.25} + \underset{(48.05)}{0.0552} \cdot GNPN$$

$D\text{–}W = 1.30;\ \bar{R}^2 = 0.990$

(7) Corporate tax

$$\ln TC = -1.30 + 1.057 \cdot \ln YC$$
$$\quad\quad (-3.22) \quad (21.89)$$

$$D\text{–}W = 0.58; \bar{R}^2 = 0.952$$

(8) Indirect tax

$$TI = 155.98 + 0.0686 \cdot GNPN$$
$$\quad (1.85) \quad (79.26)$$

$$D\text{–}W = 1.20; \bar{R}^2 = 0.996$$

(9) Capital consumption allowance

$$DEP = 505.16 + 0.1053 \cdot \left(\frac{KP \cdot ID}{100}\right)_{-1}$$
$$\quad (1.51) \quad (37.90)$$

$$D\text{–}W = 0.50; \bar{R}^2 = 0.984$$

(10) Desired inventory stock

$$\ln KJPR = -3.114 + 1.152 \ln GNPR$$
$$\quad (-11.6) \quad (49.9)$$

$$D\text{–}W = 0.55; \bar{R}^2 = 0.993$$

(11) Inventory investment

$$\ln JPR = 2.136 + 0.713 \ln (KJPR - KJPR_{-1})$$
$$\quad (2.6) \quad (6.43)$$

$$D\text{–}W = 2.51; \bar{R}^2 = 0.704$$

2. Aggregated Demand

(12) Personal consumption of ordinary goods and services (real terms)

$$\left(\frac{C1R}{EAC} \cdot 100\right) = \underset{(13.6)}{97.62} + \underset{(62.5)}{0.7621}$$

$$\cdot \left(\frac{YDD - GNKTR}{C1D \cdot EAC} \cdot 10000\right)$$

$$+ 1.0 \cdot \left(\frac{GNKTR}{C1D \cdot EAC} \cdot 10000\right)$$

$$\underset{(-8.04)}{-3.639} \left(\frac{\Delta C1D}{C1D_{-1}} \cdot 100\right)$$

$$\underset{(-5.29)}{-34.92} \left(\frac{UN}{LN} \cdot 100\right)$$

$$D\text{–}W = 1.77; \bar{R}^2 = 0.999$$

(13) Personal consumption of medical goods and services (nominal terms)

$$C2N = 269.86 + 1.253 \cdot SMX$$
$$\quad (6.51) \quad (135.5)$$

$$D\text{–}W = 1.71; \bar{R}^2 = 0.999$$

(14) Housing investment (real terms)

$$HOUI = \overline{REP} \cdot HLD_{-1} + \Delta HLD$$

$$IHR = \overline{RCOST} \cdot HOUI$$

(15) Fixed business investment (real terms)

$$IPR = \underset{(2.09)}{0.7625} + \underset{(26.5)}{0.864}$$

$$\cdot \ln \sum_{t=1}^{3} \left(\frac{SP + SC + DEP}{3 \cdot IPD} \cdot 100\right)_{-t}$$

$$+ \underset{(3.61)}{3.319} \cdot \ln \left(\frac{GNPR}{GNPR_{-1}}\right)_{-1}$$

$$D\text{–}W = 1.42; \bar{R}^2 = 0.976$$

(16) Fixed capital investment by government

$$IGN = \bar{\phi} \cdot GNPN$$

(17) Consumption expenditure by government

$$CGN = \bar{\gamma} \cdot GNPN$$

(18) Surplus of Current Account

$$EXR - IMR = \overline{ALAPH} \cdot GNPR$$

3. Wage and Employment

(19) Unemployment

$$\ln UN = \underset{(-1.51)}{-\,52.781} + \underset{(1.59)}{8.393}\ \ln LN - \underset{(-1.83)}{3.033}\ \ln GNPR + \underset{(2.56)}{2.832}\ \ln \left(\frac{WAGE}{GNPD}\right)$$

$D-W = 1.70;\ \bar{R}^2 = 0.848$

(20) Number of employees

$$\ln LW = \underset{(-1.52)}{-\,1.271} + \underset{(2.21)}{0.319} \cdot \ln LD + \underset{(16.7)}{0.823} \cdot \ln LW_{-1}$$

$D-W = 1.99;\ \bar{R}^2 = 0.999$

(21) Hours worked

$$\ln h = \underset{(78.4)}{5.664} - \underset{(-13.6)}{0.1339} \cdot \ln \left(\frac{WAGE}{CPD}\right)$$

$D-W = 0.83;\ \bar{R}^2 = 0.916$

(22) Wage rate

$$\left(\frac{\Delta WAGE}{WAGE_{-1}} \cdot 100\right) = \underset{(3.37)}{10.883} + \underset{(8.39)}{0.9636} \cdot \left(\frac{\Delta CPD}{CPD_{-1}} \cdot 100\right) + \underset{(1.77)}{0.2248} \cdot \frac{\Delta(GNPR/LD)}{(GNPR/LD)_{-1}} \cdot 100 - \underset{(-3.45)}{4.062}\left(\frac{UN}{LN} \cdot 100\right)$$

$D-W = 0.92;\ \bar{R}^2 = 0.899$

4. Deflators

(23) Deflator for consumption of ordinary goods and services

$$C1D = \underset{(6.9)}{1.653} + \underset{(292)}{97.84} \cdot CPD / 100$$

$D-W = 0.57;\ \bar{R}^2 = 0.999$

(24) Personal consumption deflator

$$\ln \left(\frac{CPD}{100}\right) = \underset{(0.54)}{0.384} + \underset{(8.80)}{0.7215}\ \ln \left(\frac{YW + SIE}{LW} \cdot 10000\right) - \underset{(-3.34)}{0.3782} \cdot \ln \left(\frac{GNPR}{LD} \cdot 10000\right) + \underset{(0.36)}{0.0248} \cdot \ln \overline{MD}/100$$

$D-W = 0.30;\ \bar{R}^2 = 0.998$

(25) Fixed business investment deflator

$$\ln \left(\frac{IPD}{100}\right) = \underset{(-18.61)}{-\,5.273} + \underset{(13.25)}{0.5763} \cdot \ln \left(\frac{YW + SIE}{LW} \cdot 10000\right) - \underset{(-7.27)}{0.5484} \left(\frac{GNPR}{LD} \cdot 10000\right)$$

$D-W = 0.80;\ \bar{R}^2 = 0.972$

(26) Government consumption deflator

$$\ln \left(\frac{CGD}{100}\right) = \underset{(-34.1)}{-\,8.661} + \underset{(35.0)}{0.8666} \cdot \ln \left(\frac{YW + SIE}{LW} \cdot 10000\right) - \underset{(-3.8)}{0.1614}\ \ln \left(\frac{GNPR}{LD} \cdot 10000\right)$$

$D-W = 0.51;\ \bar{R}^2 = 0.979$

(27) Government fixed capital investment

$$\ln\left(\frac{IGD}{100}\right) = \underset{(-4.61)}{-2.981} + \underset{(3.43)}{0.4259} \cdot \ln\left(\frac{YW + SIE}{LW} \cdot 10000\right) \underset{(-1.04)}{- 0.1786} \cdot \ln\left(\frac{GNPR}{LD} \cdot 10000\right) + \underset{(2.42)}{0.2579} \cdot \ln(\overline{MD}/100)$$

$$D\text{–}W = 0.80; \bar{R}^2 = 0.972$$

(28) GNP deflator

$$\ln GNPD = \underset{(0.29)}{0.069} + \underset{(27.2)}{0.628} \cdot \ln\left(\frac{YW + SIE}{LW} \cdot 10000\right) \underset{(-6.33)}{- 0.3782} \cdot \ln\left(\frac{GNPR}{LD} \cdot 10000\right)$$

$$D\text{–}W = 0.73; \bar{R}^2 = 0.997$$

(29) Total fixed investment deflator

$$\ln(ID/100) = \underset{(-5.19)}{-2.315} + \underset{(10.36)}{0.4504} \cdot \ln\left(\frac{YW + SIE}{LW} \cdot 10000\right) \underset{(-3.41)}{- 0.2573} \cdot \ln\left(\frac{GNPR}{LD} \cdot 10000\right)$$

$$D\text{–}W = 1.02; \bar{R}^2 = 0.977$$

5. Definitions and Identities

(30) Personal consumption of ordinary goods and services (nominal terms)

$$C1N = C1R \cdot C1D / 100$$

(31) Total personal consumption (nominal terms)

$$CPN = C1N + C2N$$

(32) Total personal consumption (real terms)

$$CPR = CPN / CPD \cdot 100$$

(33) Nominal GNP

$$GNPN = GNPR \cdot GNPD / 100$$

(34) Disposable income

$$YD = GNPN - TAX - SI - DEP + TR - SC + SB$$

(35) Adjusted disposable income

$$YDD = YD - TR + GNKTR - (SMX - SMTR)$$

(36) Number of employed persons

$$LD = LN - UN$$

(37) Personal savings

$$SP = YD - CPN$$

(38) Corporate savings

$$SC = YC - YC - DIV$$

(39) Current surplus of government

$$SG = (TAX + SI) - (CGN + TR + SB)$$

(40) Total savings

$$S = SP + SC + SG + DEP$$

(41) Investment-savings balance

$$IR = S / (ID/100)$$

(42) Government subsidies

$$SB = \beta \cdot GNPN$$

Chapter XIII

SOCIAL SECURITY SUBMODEL

A. OVERVIEW OF JAPAN'S SOCIAL SECURITY SYSTEM

Japan's social security system consists of such programmes as (i) public assistance, (ii) welfare services, (iii) social insurance schemes in the field of medical care, pension, child allowances, unemployment and workers' accident compensation, and (iv) public health. Among these programmes, both pension insurance and medical insurance schemes will be the most important in terms of the magnitude of the likely impact of population aging on the social security system [43].

At present, the public pension system consists of eight different schemes, reflecting the fact that Japan's social insurance system has been formed and developed largely on the basis of occupational groups. For example, the Employees' Pension Scheme (EPPS) has been available for employees in general. Furthermore, a seamen's insurance scheme has been in operation for sailors, and a public servants' insurance scheme has been available for government employees. Besides these schemes for employees, there is also a pension scheme for non-employees called the National Pension Scheme (NTPS).

Table XIII.1. shows the number of insured persons in each of these pension schemes. EPPS and NTPS cover approximately 90 per cent of the total number of the insured persons. Each scheme has a different level of benefits, contributions and government subsidies.

Table XIII. 1. Number of insured persons in selected pension schemes

(unit: thousand persons)

	1975	1979
Employees' Pension	23 649	24 714
National Pension	25 884	27 851
Seamen's Pension	244	211
Others	5 678	5 950
Total	55 455	58 726

Source: Prime Minister's Office, *Statistical Yearbook on Social Security*, 1979 version.

In EPPS, the benefit formula applied to the old-age pension is based on the double-decker approach, being comprising two distinct components: a flat part and an income-proportional part. The rate of benefit for the former depends solely upon the length of enrollment, while the latter varies with the level of each member's remuneration. Under the 1980 revised rules, the annual benefit of the old-age pension is calculated on the basis of the following formula:

> Amount of benefits (in 1980 price) = [2,000 yen · insured period (months) + average standard remuneration · 10/1,000 · insured period (months)].

Note that the benefit level is automatically revised in accordance with the rise of price indices.

Under this pension scheme, each member is entitled to receive his benefit payment at the age of 60. The financial resources for such benefits consist of contributions, government subsidies and interest earnings accrued from its reserve fund. According to the 1980 revised regulations, the contribution rate is 5.3 per cent for male workers' remuneration, 4.45 per cent for female workers' remuneration and 5.9 per cent for coal miners' remuneration. Equal contributions are shared by their employers. In addition, the subsidies which amount to 20 per cent of the benefit payments are provided by the Government. The reserve fund is estimated to amount to 24,352 billion yen by the end of 1979, which is about 9 times as large as its benefit payments, as shown in Table XIII.2.

NTPS consists of both contributory and non-contributory schemes. The non-contributory scheme, which is called the Welfare Pension Scheme, provides a minimum level of income to pensioners aged 70 or over who were too old to be eligible for the contributory scheme when NTPS was instituted in 1959. Under this scheme, each member can receive benefits from age 65. It is financed through the regular government budget. On the other hand, the contributory scheme is financed by flat-rate contributions paid by insured persons and by government subsidies. The benefit is calculated as follows:

> Amount of benefits (in 1980 price) = (1,680 yen · the number of months contribution paid) +

Table XIII.2. Financial status of employees' pension scheme
(unit: billion yen)

	1975	1979
Total revenue	3 137.0	5 982.0
Contributions	2 202.0	3 988.0
Government subsidies	173.8	464.4
Interest earnings	751.0	1 511.3
Others	10.2	18.3
Total expenditure	988.8	2 735.2
Insurance benefits	953.7	2 655.7
Others	35.1	79.5
Balance	2 148.1	3 246.8
Reserve fund	12 286.9	24 351.9

Source: Same as Table XIII.1.

Table XIII.3. Financial status of national pension scheme
(unit: billion yen)

	1975	1979
Total revenue	693.8	1 691.5
Contributions	369.0	1 005.9
Government subsidies	213.3	521.4
Interest earnings	109.3	125.3
Others	2.2	38.9
Total expenditure	462.4	1 358.9
Insurance benefits	456.6	1 342.6
Others	5.8	16.3
Balance	231.4	332.6
Reserve fund	1 814.7	2 359.6

Source: Same as Table XIII.1.

(1,680 yen · the number of months contribution exempted · 1/3).

As shown in Table XIII.3. the financial status of NTPS is not as favourable as that of EPPS. One can easily understand this by comparing the ratio of total expenditures to the reserve fund for both NTPS and EPPS. In 1979, it is 0.576 for NTPS and 0.112 for EPPS.

The benefit levels of these pension schemes have been repeatedly raised in recent years, especially in 1973, as a result of rising prices and productivity. Consequently, the benefit levels of the EPPS old-age pension, for instance, are highly comparable to those of Western nations in terms of percentage of the average wage. As for NTPS, the full statutory pension level which a married couple receives is about equivalent to the average pension of EPPS. Because of the relative delay in the inception of NTPS, the current benefit level of NTPS actually received in pensions is very low. The degree to which this pension system has matured is still small by international standards. This immaturity coupled with the accelerating aging of the Japanese population, will lead to a rapid rise in public pension expenditures as well as increasing contributions in the years to come.

The existing medical care insurance system consists of eight different schemes for the same reasons as in the case of the public pension system. The current medical system can be roughly divided into the following two groups: employees' insurance for employed persons and the community insurance for residents.

As for the employees' insurance, there are two health insurance schemes for employees in general and four schemes for employees in particular occupational fields. One of the former two schemes is the government-managed health insurance plan (GMHIP) for employees in medium and small-sized firms, with the government serving as the sole insurer. The other scheme is the association-managed health insurance plan (AMHIP), for which the Health Insurance Association, jointly organized by both management and employees of a big firm of a group of firms in the same industry, serves as the sole insurer.

The community health insurance scheme, the National Health Insurance Plan (NTHIP), is for those persons who are not covered by any of the above-mentioned insurance scheme for employees. It is either managed by local authorities or by National Health Insurance Associations, each formed within the same occupation (such as doctors and carpenters). Table XIII.4. shows the number of persons insured under these various schemes. Note that GMHIP, AMHIP and NTHIP cover almost all insured persons.

The medical benefits under these health insurance plans consist of benefits in kind as well as in cash. The

Table XIII.4. Number of insured persons in various health insurance plans

(unit: thousand persons)

	1975	1979
Government-managed		
Health Insurance Plan	28 124	30 602
Insured persons	13 285	14 251
Family dependents	14 839	16 351
Association-managed		
Health Insurance Plan	26 094	27 028
Insured persons	10 984	11 193
Family dependents	15 110	15 835
National Health Insurance Plan	43 996	44 552
Others	13 576	13 750
Total	111 790	115 932

Source: Same as Table XIII.1.

Table XIII.5. Annual growth rate of total medical cost and its contributing factors from 1965 to 1979

(unit: per cent)

	GMHIP (the insured person)	GMHIP (family dependent)	NTHIP
Total medical cost	14.9	20.0	19.0
Number of the insured (Number of family dependents)	1.4	2.2	0.4
Frequency of medical treatments	1.1	3.4	4.1
Medical cost per case	12.3	14.3	14.4

Source: Same as Table XIII.1.

benefit ratio (which measures the proportion of medical benefits in kind to the total medical expenditure) for the employees' health insurance plans is 100 per cent for the insured and 80 per cent for their family dependents (20 per cent paid by the patient). As for NTHIP, the benefit ratio is 70 per cent. In addition to the medical benefit in kind, cash benefits are also provided under the health insurance system, in such forms as sickness and injury allowances and maternity allowances. Total medical costs are composed of three factors; the number of insured persons (or family dependents), the frequency of medical treatments and the medical cost per case, Table XIII.5.shows the annual growth rate of each of these factors from 1965 to 1979, in terms of insured persons and their dependents under MGHIP, and insured persons under NTHIP.

The following two points are worth noting. First, the annual growth rate of the total medical cost is higher than that of nominal GNP (14.5 per cent) during the corresponding period. Secondly, about two-thirds of the growth of total medical cost are attributed to the growth of the medical cost per medical case. The growth rates of the total medical cost are reflected in changes in the financial status of each health insurance scheme. The financial structural changes of GMHIP are shown in Table XIII.6. its cumulative deficit in 1979 amounting 129.6 billion yen. To cope with these trends, GMHIP called for repeated changes in its contribution rate and both maximum and minimum levels of standardized remuneration. In 1980 its contribution rate was 8 per cent of standardized remuneration.

In contrast, the financial structure of AMHIP is in a comparatively more favourable state than that of GMHIP, as presented in Table XIII.7. This is due to the fact that AMHIP covers the large sized enterprises in which wage levels are substantially higher. Moreover, as indicated in Table XIII.8. in the case of the National Health Insurance Plan, the condition of its financial structure has been improving through the strengthening of its financial basis with heavy government subsidies as well as through increasing contributions rates imposed upon its insurance carriers. The soundness of its future financial status, however, involves many uncertainties.

B. THE BASIC STRUCTURE OF THE SOCIAL SOCIETY MODEL

In this sub-model, the social security system is disaggregated into the following groups: the public pension insurance component and the health insurance component. The core of the former consists of the Employees' Pension Scheme (EPPS) and the National Pension Scheme (NTPS). The latter includes the Government-managed Health Insurance Plan (GMHIP), Association-managed Health Insurance Plan (AMHIP), and National Health Insurance Plan (NHIP). In addition to these two components, the Social Security Submodel of this study implicitly deals with other social security programmes. The basic framework of the pension is based on the institutional characteristics of both FPPS and NTPS as described in the previous section. These schemes have been in operation under the reserve financing schemes. It is certain, however, that due to

Table XIII.6. Changes in financial status of government-managed health insurance plan, 1975-1979

(unit: billion yen)

	1975	1976	1977	1978	1979
Revenue	1 483.6	1 735.4	1 994.4	2 334.8	2 558.3
Expenditure	1 514.9	1 791.5	2 009.7	2 322.2	2 560.6
Surplus of each year	–31.2	–56.1	–15.3	–12.6	–2.3
Cumulative surplus	–68.0	–124.1	–139.4	–126.7	–129.6

Source: Same as Table XIII.1.

Table XIII.7. Changes in financial status of society-managed health insurance plan, 1975-1979

(unit: billion yen)

	1975	1979
Revenue	1 376.9	2 199.2
Contribution	1 275.2	2 003.7
Expenditure	1 283.3	1 030.4
Benefit, paid out	1 106.1	1 766.1
Surplus	93.6	168.8

Source: Same as Table XIII.1.

Table XIII.8. Changes in financial status of national health insurance plan, 1975-1979

(unit: billion yen)

	1975	1979
Revenue	1 843.3	3 428.7
Contributions	591.2	1 170.5
Government subsidies	1 078.5	1 959.0
Expenditure	1 801.3	3 304.6
Benefits paid out	1 666.0	3 132.1
Surplus	41.9	124.2

Source: Same as Table XIII.1.

repeated changes in the benefit levels, the financing structure of both pension schemes will be unavoidably shifted to the pay-as-you-go (PAYG) system in due course. Our social security submodel incorporates these two alternative financing methods. The transfer from reserve financing to PAYG financing is automatically done on the basis of the following criterion: if the contribution rate computed under the PAYG system is greater than that under the reserve financing system, the pension scheme starts operating under the PAYG system.

The reserve financing system can be described by the following nine equations. The first equation is related to the budgetary surplus (GAP) in the i-th scheme, as shown below. (A variable with a bar above its notation is exogenously determined.)

$$GAP_i = SI_i + GS_i + IR_i - TR_i - \overline{OTH}_i$$

where
SI_i: contribution
GS_i: government subsidies
IR_i: interest earnings
TR_i: benefit paid out, and
OTH_i: other expenditure

Furthermore, the contribution to the i-th social insurance scheme (SI_i) is a function of the contribution rate ($\overline{RSI}_i$), the wage rate (WAGE) from the economic submodel and the number of insured persons (PI_i).

$$SI_i = f(\overline{RSI}_i \cdot Wage \cdot PI_i)$$

PI_i, the last term of the above function, depends on the number of employees (LW) or the self-employed

(LD-LW), both of which are obtained from the Economic Submodel.

$$PI_i = f(LW, LD\text{-}LW)$$

The level of government subsidies (GS_i) can be defined as a given percentage ($\overline{RGS}_i$) of benefits paid out (TR_i).

$$GS_i = \overline{RGS}_i \cdot TR_i$$

Interest earnings (IR_i) are computed as the product of the nominal interest rate ($\overline{R}$) and the level of the reserve fund at the end of the previous period (RF_{i-1}).

$$IR_i = \overline{R} \cdot RF_{i-1}$$

Note that insurance benefits paid out (TR_i) include not only those for an old-age pension (PN_i) but also other pensions such as aggregate old-age pensions, pensions for invalids and surviving dependents.

For simplicity's sake, only old-age pensions (PN_i) are treated explicitly in this model. For this reason, a conversion factor (RTR_i) to link old-age pensions (PN_i) to the total insurance benefits (TR_i) is used as shown below:

$$TR_i = RTR_i \cdot PN_i$$

By definition, the old-age pension benefit is the product of the number of beneficiaries ($\overline{BF}_i$) and the average level of the old-age pension benefit ($PCPN_i$), as expressed below.

$$PN_i = \overline{BF}_i \cdot PCPN_i$$

Although $\overline{BF}_i$ is treated exogenously, the average old-age pension level ($PCPN_i$) (which is a given percentage ($\overline{RPN}_i$) of the nominal wage rate (WAGE)) is derived from the Economic Submodel.

$$PCPN_i = \overline{RPN}_i \cdot WAGE$$

The final equation under the reserve financing scheme is the level of the reserve fund (RF) which is determined as follows:

$$RF_i = RF_{i-1} + GAP_i$$

In contrast, under the PAYG system, benefit payments are matched by an equal amount of contributions. Drawing upon this functional relationship, one can relate contributions (SI_i) to benefit payments (TR) as follows:

$$SI_i = TR_i + \overline{OTH}_i - GS_i - IR_i$$

In addition, the contribution rate (RSI_i) is generated from the following equation:

$$RSI_i = f(SI_i)/WAGE \cdot PI_i$$

A parallel analysis is applicable to health insurance schemes. Some further explanation, however, is needed for medical expenditures.

As previously explained, the medical cost of the i-th health plan (MC_i) is disaggregated into the frequency of medical treatments, the number of the insured pension (or family dependents) and the cost per medical case. It is important to note that the frequency of medical treatment is treated as an exogenous variable. Moreover, the number of insured persons are determined on the basis of the number of employees and/or self-employed, both of which come from the Economic Submodel. The medical cost per case under health plan is determined by the aggregate medical cost per case. More importantly, this aggregate medical cost per case is determined through changes in *per capita* nominal GNP (economic submodel) and the ratio of those aged 65 and over (POP 65+) to those aged 15-64 (POP 15-64). The rationale behind the inclusion of these variables into this function is that the aggregate medical cost per case rises with an increase in both the standard of living and the relative burden which the aged population places upon the working-age population. Variations in *per capita* nominal GNP come from the Economic Submodel, while those in demographic factors come from the Population Submodel.

In the above, we have discussed an institutional and theoretical framework of the Social Security Submodel. In the ensuing section, a complete list of behavioural equations, definitions and identities related to the Social Security Submodel will be presented.

Notation

Note that the unit of all the money-related variables is billion yen, unless they are specified otherwise. The unit of all the population-related variables is thousand persons.

Employee's Pension Scheme

GAPEP surplus

SIEP	contribution
GSEP	government subsidies
IREP	interest earnings
TREP	benefit paid out
OTHEP	other expenditure
RSIEP	contribution rate
PIEP	insured persons
RGSEP	ratio of government subsidies to benefit payments
RFEP	reserve fund
PNEP	old-age pension benefit
RTREP	conversion factor to relate old-age pension benefit to total benefit
PCPNEP	average per capita old-age pension benefit level (thousand yen)
BFEP	number of old-age pension beneficiaries
RPNEP	ratio of average old-age pension level to nominal wage

National Pension Scheme

GAPNT	surplus
SINT	contribution
GSNT	government subsidies
IRNT	interest earnings
TRNT	benefit paid out
OTHNT	other expenditure
RSINT	contribution rate
PINT	number of insured persons
RGSNT	ratio of government subsidies to benefit payments
RFNT	reserve fund
PNNT	old-age pension benefit
RTRNT	conversion factor to link old-age pension benefit to total benefit
PCPNNT	average per capita old-age pension benefit level (thousand yen)
BFNT	number of old-age pension beneficiaries
RPNNT	ratio of average old-age pension level to nominal wage
TRWP	welfare pension benefit
PNWP	old-age pension benefit
BFWP	number of old-age pension beneficiaries
PCPNWP	average per capita old-age pension benefit level (thousand yen)
RTRWP	conversion factor to link old-age pension benefit to welfare pension benefit

Government-managed Health Insurance Plan

SIGM	contribution
TRGM	insurance benefit
OTHGM	other expenditure
GSGM	government subsidies
GAPGM	surplus
RSIGM	contribution rate
PIGM	number of insured persons
PFGM	number of family dependents
RPFGM	ratio of family dependents to insured persons
RGSGM	ratio of government subsidies to benefits paid out
MBGM	medical benefit
MCIGM	medical costs incurred for insured persons
MCFGM	medical costs incurred for family dependents
RMGIGM	benefit ratio for insured persons
RMCFGM	benefit ratio for family dependents
CRIGM	frequency of medical treatments for insured persons
CRFGM	frequency of medical treatments for family dependents
MCPDIGM	medical cost per case for insured persons (million yen)
MCPDFGM	medical cost per case for family dependents (million yen)
MCPDA	aggregate medical cost per case (million yen)
MPR	medical price (1962 = 100)

Association-managed Health Insurance Plan

SIAM	contribution
TRAM	benefit paid out
OTHAM	other expenditure

GSAM	government subsidies
GAPAM	surplus
RSIAM	contribution rate
PIAM	number of insured persons
PFAM	number of family dependents
RPFAM	ratio of family dependents to insured persons
RGSAM	ratio of government subsidies to benefits paid out
MBAM	medical benefit
MCIAM	medical cost incurred for insured persons
MCFAM	medical costs incurred for family dependents
RMCIAM	benefit ratio for insurred persons
RMCFAM	benefit ratio for family dependents
CRIAM	frequency of medical treatments for family dependents
MCPDIAM	medical cost per case for insured persons (million yen)
MCPDFAM	medical cost per case for family dependents (million yen)

National Health Insurance Plan

SINH	contribution (million yen)
TRNH	benefit paid out
OTHNH	other expenditure
GSNH	government subsidies
GAPNH	surplus
RSINH	contribution rate
PIGM	number of insured persons
RGSNH	ratio of government subsidies to benefits paid out
MBNH	medical benefit
MCINH	medical costs for insurred persons
RMCINH	benefit ratio for insured persons
CRINH	frequency of medical treatments for insured persons
MCPDINH	medical cost per case for insured persons (million yen)
HINH	number of insured households (thousand households)
RHINH	ratio of insured households to insured persons
RPZNH	conversion factor
PITOT	number of insured persons and family dependents in all health insurance plans for employees

Aggregate Variables

SMX	aggregate medical costs
SMTR	aggregate medical benefits
TR	total social security benefits
TRPN	total pension benefits
TRME	total medical benefits
TROTH	total of other benefits
SI	contribution to the social security system
SIE	contribution made by employers to the social security system
GNKTR	total cash benefits paid out by government

C. THE SYSTEM OF EQUATIONS

All the equations included in this section have been estimated on the basis of annual data over the period of 1963-1979, by means of ordinary least squares. The data utilized have been gathered from various government published documents [20] [22]. The overall relationship of these equations is described in Figure V-1.

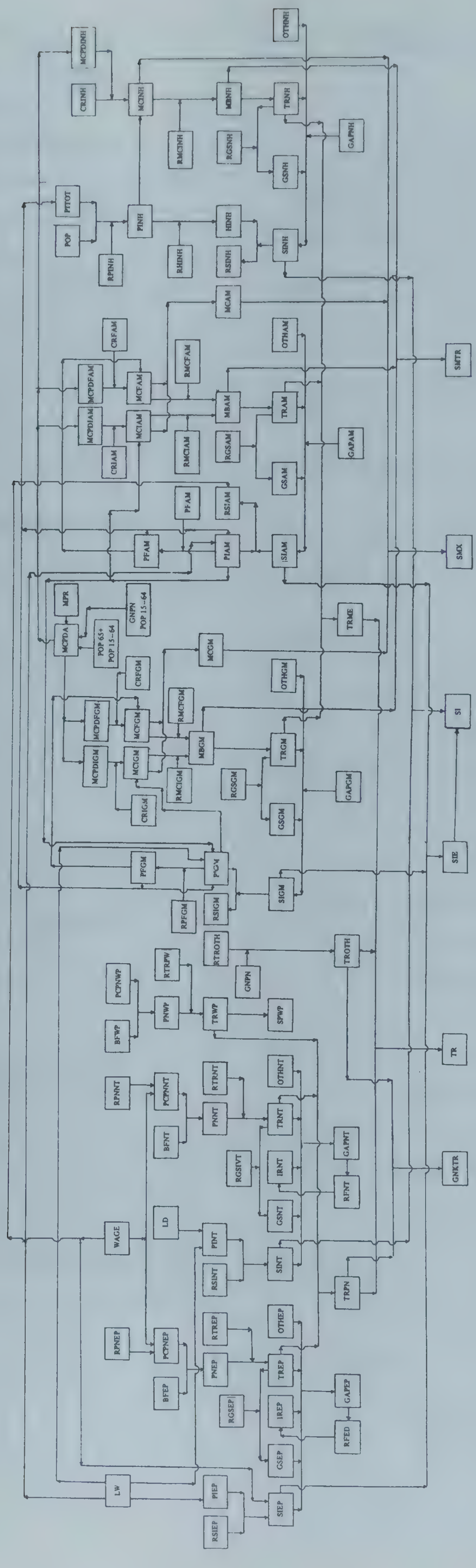


Figure XIII.1. Schematic charts of the social security submodel

1. Employee's Pension Scheme

(1) Surplus

$$GAPEP = SIEP + GSEP + IREP - TREP - \overline{OTHEP}$$

(2) Contribution

[Reserve financing syst:m]

$$SIEP = \underset{(-1.61)}{-28.37} + \underset{(111)}{0.6215} \cdot \overline{RSIEP} \cdot WAGE \cdot PIEP / 10^3$$

$$D-W = 0.78; \overline{R}^2 = 0.999$$

(3) Government subsidies

$$GSEP = \overline{RGSEP} \cdot TREP$$

(4) Interest earnings

$$IREP = \underset{(-1.15)}{-8.191} + \underset{(78.15)}{0.07371} \cdot RFEP_{-1}$$

$$D-W = 0.89, \overline{R}^2 = 0.998$$

(5) Reserve fund

$$RFEP = RFEP_{-1} + \underset{(1.12)}{0.9015} + \underset{(2241)}{0.9983} \cdot GAPEP$$

$$D-W = 2.15; \overline{R}^2 = 0.999$$

(6) Benefit paid out

$$TREP = \overline{RTREP} \cdot PNEP$$

(7) Old-age pension benefit

$$PNEP = PCPNEP \cdot \overline{BFEP}$$

(8) Average old-age pension benefit level

$$PCPNEP = \overline{RPNEP} \cdot WAGE$$

(9) Number of insured persons

$$PIEP = \underset{(1.19)}{1075.6} + \underset{(23.1)}{6.245} \cdot LW$$

$$D-W = 0.44; \overline{R}^2 = 0.971$$

2. National Pension Scheme (Contributory Component)

(10) Surplus

$$GAPNT = SINT + GSNT + IRNT - TRNT - - \overline{OTHNT}$$

(11) Contribution

[Reserve financing system)

$$SINT = \underset{(0.54)}{2.975} + \underset{(70.25)}{0.9111} \cdot \overline{RSINT} \cdot 12.0 / 10^6 \cdot PINT$$

$$D-W = 1.46; \overline{R}^2 = 0.997$$

[Pay-as-you-go-financing-system]

$$SINT = TRNT + \overline{OTHNT} - GSNT - IRNT$$

(12) Government subsidies

$$GSNT = \overline{RGSIVT} \cdot TRNT$$

(13) Interest earnings

$$IRNT = \underset{(2.74)}{3.763} + \underset{(52.52)}{0.0604} \cdot RFNT_{-1}$$

$$D-W = 0.35; \overline{R}^2 = 0.995$$

(14) Reserve fund

$$RFNT = RFNT_{-1} + \underset{(0.13)}{1.6075} + \underset{(13.1)}{0.9423} \cdot GAPNT$$

(15) Benefit paid out

$$TRNT = \overline{RTRNT} \cdot PNNT$$

(16) Total old-age pension benefit

$$PNNT = PCPNNT \cdot \overline{BFNT}$$

(17) Average old-age pension benefit level

$$PCPNNT = \overline{RPNNT} \cdot WAGE$$

(18) Insured pensions

$$PINT = \underset{(-2.29)}{-18558} + \underset{(2.28)}{6.3161} \cdot (LD - LW) + \underset{(9.55)}{9.4196} \cdot LW$$

$$D{-}W = 1.58; \bar{R}^2 = 0.985$$

3. National Pension Scheme (Non-Contributory Component)

(19) Total of welfare pension benefit

$$TRWP = \overline{RTRWP} \cdot PNWP$$

(20) Old-age pension benefit

$$PNWP = \overline{PCPNWP} \cdot BFWP$$

4. Government-Managed Health Insurance Plan

(21) Contribution

$$SIGM = TRGM + OTHGM - GSGM - \overline{GAPGM}$$

(22) Contribution rate

$$SIGM = \underset{(-1.46)}{-18.837} + \underset{(82.7)}{0.646} \cdot RSIGM \cdot WAGE \cdot PIGM / 10000$$

$$D{-}W = 0.41; \bar{R}^2 = 0.998$$

(23) Number of insured persons

$$PIGM = \underset{(1.86)}{1602.229} + \underset{(24.26)}{6.2795} \cdot LW$$

$$D{-}W = 0.50; \bar{R}^2 = 0.974$$

(24) Number of family dependents

$$PFGM = \overline{RPFGM} \cdot PIGM$$

(25) Government subsidies

$$GSGM = \overline{RGSGM} \cdot TRGM$$

(26) Benefit paid out

$$TRGM = \underset{(0.01)}{0.3201} + \underset{(54.81)}{1.0819} \cdot MBGM$$

$$D{-}W = 3.04; \bar{R}^2 = 0.995$$

(27) Medical benefit

$$MBGM = MCIGM \cdot \overline{RMCIGM} + MCFGM \cdot \overline{RMCFGM}$$

(28) Medical cost

$$MCGM = MCIGM + MCFGM$$

(29) Medical cost incurred for insured persons

$$MCIGM = PIGM \cdot \overline{CRIGM} \cdot MCPDIGM$$

(30) Medical cost incurred for family dependents

$$MCFGM = PFGM \cdot \overline{CRFGM} \cdot MCPDFGM$$

(31) Medical cost per case for insurred persons

$$MCPDIGM = \underset{(6.97)}{0.0008} + \underset{(69.8)}{1.134} \cdot MCPDA$$

$$D{-}W = 0.33; \bar{R}^2 = 0.997$$

(32) Medical cost per case for family dependents

$$MCPDFGM = \underset{(-7.9)}{-0.00047} + \underset{(107)}{0.8964} \cdot MCPDA$$

$$D{-}W = 0.29; \bar{R}^2 = 0.999$$

(33) Aggregate medical cost per case

$$\ln MCPDA = \underset{(-3.23)}{-5.4811} + \underset{(5.27)}{0.6828} \cdot \overline{MPR}$$

$$+ \underset{(6.26)}{0.4051} \cdot \ln \text{GNPN/POP15-64}$$

$$+ \underset{(2.88)}{1.476} \cdot \ln \text{POP65+/POP15-64}$$

$$\text{D-W} = 1.00; \bar{R}^2 = 0.998$$

5. Association-Managed Health Insurance Plan

(34) Contribution

$$\text{SIAM} = \text{TRAM} + \text{OTHAM} - \text{GSAM} - \overline{\text{GAPAM}}$$

(35) Contribution rate

$$\text{SISA} = \underset{(-1.16)}{-17.428} + \underset{(67.78)}{0.7864} \cdot \text{RSISA} \cdot \text{WAGE}$$

$$\cdot \text{WAGE} \cdot \text{PISA} / 1000$$

$$\text{D-W} = 0.37; \bar{R}^2 = 0.997$$

(36) Number of insurred persons

$$\text{PISA} = \underset{(-7.0)}{-4185.7} + \underset{(23.0)}{4.1305} \cdot \text{LW}$$

$$\text{D-W} = 0.44; \bar{R}^2 = 0.971$$

(37) Number of family dependents

$$\text{PFSA} = \overline{\text{RPFSA}} \cdot \text{PISA}$$

(38) Government subsidies

$$\text{GSSA} = \overline{\text{RGSSA}} \cdot \text{TRSA}$$

(39) Benefit paid out

$$\text{TRSA} = \underset{(-0.67)}{-0.8994} + \underset{(672)}{1.0744} \cdot \text{MBSA}$$

$$\text{D-W} = 1.39; \bar{R}^2 = 0.999$$

(40) Medical benefit

$$\text{MBSA} = \text{MCISA} \cdot \overline{\text{RMCISA}} + \text{MCFSA} \cdot \overline{\text{RMCFSA}}$$

(41) Medical cost

$$\text{MCSA} = \text{MCISA} + \text{MCFSA}$$

(42) Medical cost incurred for insurred persons

$$\text{MCISA} = \text{PISA} \cdot \overline{\text{CRISA}} \cdot \text{MCPDISA}$$

(43) Medical cost incurred for family dependents

$$\text{MCFSA} = \text{PFSA} \cdot \overline{\text{CRFSA}} \cdot \text{MCPDFSA}$$

(44) Medical cost per case for insurred persons

$$\text{MCPDISA} = \underset{(6.1)}{0.00046} + \underset{(94.3)}{0.9903} \cdot \text{MCPDA}$$

$$\text{D-W} = 0.32; \bar{R}^2 = 0.998$$

(45) Medical cost per case for family dependents

$$\text{MCPDFSA} = \underset{(-0.67)}{-0.00002} + \underset{(168.91)}{0.766944} \cdot \text{MCPDA}$$

$$\text{D-W} = 0.76; \bar{R}^2 = 0.999$$

6. National Health Insurance Plan

(46) Contribution

$$\text{SINH} = \text{TRNH} + \text{OTHNH} - \text{GSNH} - \overline{\text{GAPNH}}$$

(47) Contribution rate per household insurred

$$\text{RSINH} = \text{SINH} / \text{HINH}$$

(48) Number of insured households

$$\text{HINH} = \overline{\text{RHINH}} \cdot \text{PINH}$$

(49) Number of insured persons

$$\text{PINH} = \overline{\text{RPINH}} \cdot (\text{POP} - \text{PITOT})$$

(50) Insured persons and family dependents in all health insurances for employees

$$\text{PITOT} = \underset{(20.4)}{13647.1} + \underset{(72.9)}{0.9985}$$

$$\cdot (\text{PIGM} + \text{PFGM} + \text{PIAM} + \text{PFAM})$$

$$\text{D-W} = 0.79; \bar{R}^2 = 0.997$$

(51) Government subsidies

$$GSNH = \overline{RGSNH} \cdot TRNH$$

(52) Insurance benefit

$$TRNH = \underset{(-0.81)}{-0.574} + \underset{(2060.9)}{1.023} \cdot MBNH$$

$$D\text{-}W = 0.94; \overline{R}^2 = 0.999$$

(53) Medical benefit

$$MBNH = MCINH \cdot \overline{RMCINH}$$

(54) Medical cost

$$MCINH = PINH \cdot \overline{CRINH} \cdot MCPDINH$$

(55) Medical cost per case

$$MCPDINH = \underset{(-11.0)}{-0.00045} + \underset{(194)}{1.104} \cdot MCPDA$$

$$D\text{-}W = 0.55; \overline{R}^2 = 0.999$$

7. Aggregate Variables To Be Injected Into Economic Submodel

(56) Aggregated medical costs

$$SMX = \underset{(8.94)}{63.245} + \underset{(664)}{1.1222} \cdot (MCGM + MCAM + MCNH)$$

$$D\text{-}W = 1.15; \overline{R}^2 = 0.999$$

(57) Aggregated medical benefits in kind

$$SMTR = \underset{(8.14)}{45.42} + \underset{(698)}{1.1337} \cdot (MBGM + MBAM + MBNH)$$

$$D\text{-}W = 0.93; \overline{R}^2 = 0.999$$

(58) Total social security benefits

$$TR = TRPN + TRME + TROTH$$

(59) Total pension benefits

$$TRPN = \underset{(5.85)}{101.84} + \underset{(164)}{1.423} \cdot (TREP + TRNT + TRWP)$$

$$D\text{-}W = 0.34; \overline{R}^2 = 0.999$$

(60) Medical benefits

$$TRME = \underset{(2.38)}{56.79} + \underset{(167)}{1.1336} \cdot (TRGM + TRAM + TRNH)$$

$$D\text{-}W = 2.54; \overline{R}^2 = 0.999$$

(61) Other benefits

$$TROTH = \overline{RTROTH} \cdot GNPN$$

(62) Contributions to the social security system

$$SI = SINT + SINH + \underset{(0.09)}{5.849} + \underset{(97.11)}{1.7015} \cdot SIE$$

$$D\text{-}W = 2.28; \overline{R}^2 = 0.998$$

(63) Contributions made by employers to the social security system

$$SIE = \underset{(-0.11)}{-5.623} + \underset{(77.9)}{1.9402} \cdot \frac{1}{2} (SIEP + SIGM + SIAM)$$

$$D\text{-}W = 2.49; \overline{R}^2 = 0.997$$

(64) Cash benefits paid out

$$GNKTR = TRPN + \underset{(3.28)}{87.45} + \underset{(74.4)}{0.689} \cdot TROTH$$

$$D\text{-}W = 2.00, \overline{R}^2 = 0.999$$

Chapter XIV

SIMULATION RESULTS

In order to prepare the future projections of all endogenous variables in our model, we need to supply the initial value of each lagged variable and the assumed value of every exogenously determined variable. In the first section of this chapter, therefore, we will present a set of initial values and assumptions imposed upon numerous variables and parameters. In the second part of this chapter, selected numerical results of simulation experiments based upon these initial values and assumptions are described to provide a base for analysing various policy implications in the next chapter.

A. COMPUTATIONAL ASSUMPTIONS, INITIAL VALUES, AND THE SIMULATION METHOD USED

In the population submodel, both male and female enrolment rates ($ENROL^m$ and $ENROL^f$) are exogenously determined. The former affects the level of $LFPR^{m1}$, while the latter accounts for variations in both $LFPR^{f1}$ and AFM. For simulation purposes, these exogenously determined variables are assumed to change from 1980 to 2025, as depicted in Figure XIV.1. These assumed values have been derived from one of the recent studies undertaken by the Nihon University Population Research Institute (NUPRI) [28].

The base population used for future projections is the one obtained from the final count of the 1980 Population Census [26]. The reason for the use of such sample results is that it would take a considerably longer time before the Government of Japan publishes the result of its complete counts.

As far as the economic submodel is concerned, several assumptions have been made. First of all, the level of utilization of capital equipment (ρ), which takes a value of 100 in the base year 1975, is assumed to increase gradually from 118.7 in 1979 to a normal utilization level of 125 in 1990, and to remain constant thereafter. This assumed level of capital utilization roughly corresponds to the average of capital utilization rates observed over the period of 1968-1972. During this time period, the Japanese economy transformed its structure from growth-orientation to one of stability-orientation. In view of the fact that Japanese Government economic policies have been recently directed toward stable economic growth, one would regard this assumption as highly realistic.

Secondly, the proportion of capital consumption to total capital stock, θ, is assumed to fall linearly from 0.0539 to 0.03125 over the period 1979 to 2025. This value of 0.03125 corresponds to the average value of θs recently observed in the following industrialized countries: United States (4.1 per cent during 1966-1977), United Kingdom (1.2 per cent, during 1966-1977), Canada (4.8 per cent, during 1955-1977), and France (2.5 per cent, during 1966-1977) [65]. Judging from the past performance of the Japanese economy, one could easily expect that the value of θ might decline to this selected level as its economy slows down.

Thirdly, although the trade surplus, (EXR-IMR), is expressed as a fraction (ALPHA) of GNPR in the present model, we have made the assumption that the value of ALPHA would be equal to zero after the year 1986. It seems reasonable that in the long-run context the balance of international trade will become very close to zero as a result of external political forces.

Fourthly, the proportion of the sum of government consumption (CGN) and government investment (IGN) to the gross national product (GNPN) is expected to grow from 19.8 per cent in 1979 to 25 per cent in 1990, and to remain unchanged thereafter. Although the proportion has been steadily increasing in recent years, we have imposed its ceiling so as to keep our analysis as realistic as possible. Furthermore, as of 1979 the ratio of CGN to IGN was 1.018, and this proportional relationship is assumed to be constant throughout the simulation period of our study.

Fifthly, the value of the import deflator, MD, increases at an annual rate of 5 per cent, starting from 1980. Note that the value of MD for 1979 was 108.2, and that for 1975, 100.

In the social security submodel, we have incorporated far more assumptions and constraints than in other submodels. This is because the social security submodel contains a great deal of institutional and political detail. The exogenous variables included in the social security submodel can be categorized into three types as shown in Table XIV.1. Column (1) lists all the variables which stay constant throughout the simulation period; Column (2) has the variables whose values increase at an annual rate of 5 per cent; and Column (3) enumerates a set of the variables whose future changes

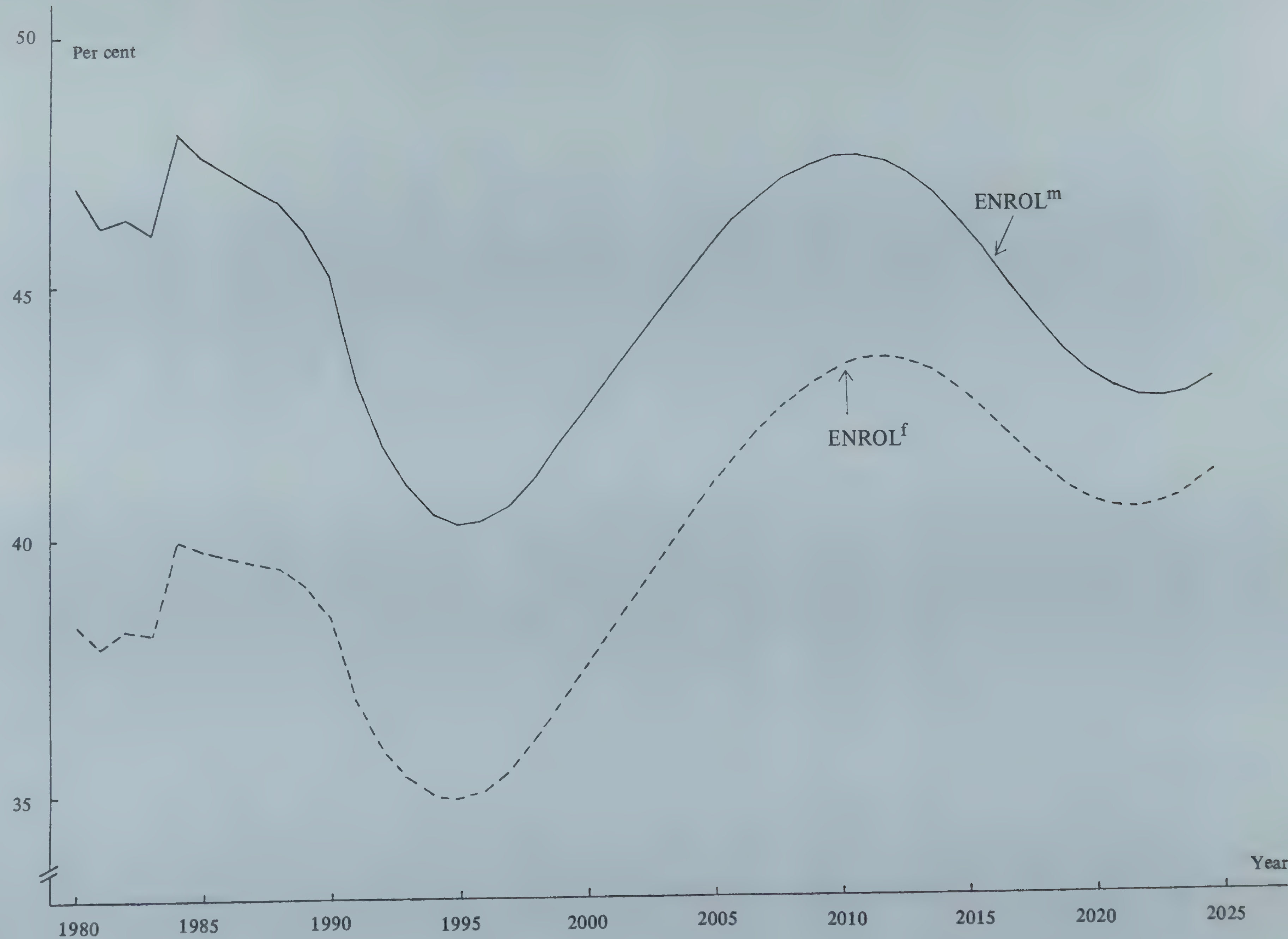


Figure XIV.1. Likely changes in both male and female educational enrolment rates, 1980-2025

Table XIV.1. The future pattern of changes in exogenously determined variables in the social security submodel

Variable	(1) Value remains unchanged at the 1979 level	(2) Value grows at 5 per cent per year from 1980	(3) Value adopted from MHW's 1980 estimates
RTROTH	0.0283		
OTHEP		x	
RSIEP			x
RGSEP	0.1749		
BFEP			x
OTHNT		x	
RSINT			x
RGSNT	0.3883		
BFNT			x
RTRWP	1.1659		
BFWP			x
PCPNWP		x	
OTHGM		x	
RPFGM	1.1474		
RGSGM	0.1722		
RMCIGM	1.0		
RMCFGM	0.7589		
CRIGM	6.6041		
MPR		x	
OTHAM		x	
RSIAM	0.7864		
RPFAM	1.4147		
RGSAM	0.0028		
RMCIAM	1.0		
RMCFAM	0.8208		
CRIAM	5.4281		
CRFAM	6.4412		
OTHNH		x	
RSINH		x	
RHINH	0.3440		
RPINH	0.9954		
RGSNH	0.6255		
RMCINH	0.7662		
CRINH	6.2032		

are based upon the estimated values prepared by the Ministry of Health and Welfare in 1980 [22].

In addition, the future pattern of changes in other exogenously determined variables such as RTREP, RPNEP, RTRNT, and RPNNT, is given by adjusting somewhat arbitrarily, the estimates of the Ministry of Health and Welfare [22]. As shown in Figure XIV.2. and XIV.3., RTREP takes a value of 1.396 in 1980 and 1.716 in 2025, RTRNT, 1.105 in 1980 and 1.601 in 2025, RPNEP, 34.715 in 1980 and 46.287 in 2025, and RPNNT, 8.836 in 1980 and 15.167 in 2025.

As discussed in the previous chapter, all the public pension schemes are presently being operated under the reserve financing principle. In the present study, however, this reserve financing system is assumed to be replaced by the pay-as-you-go (PAYG) financing system, once the contribution rate under the former system exceeds that under the latter. In view of the fact that some of the public pension schemes have virtually been operating under the PAYG system, one would regard this assumption highly realistic.

Given these initial conditions, numerical constraints and assumptions, we will present, in the following few sections, a variety of simulation results over the period of 1980-2025. In Section B, the results of the standard case will be described in great detail. In Section C experimented outcomes of the case in which the level of welfare benefits does not improve as rapidly as the standard case will be selectively highlighted, and Section D deals with simulated results based upon two alternative fertility assumptions.

Once initial conditions and computational assumptions are imposed, the dynamic structure of the present model permits values of all economic and social security variables as of year t to be calculated for values of demographic factors as of year t-1. The values of both economic and social security variables, in turn, determine those of demographic variables as of year t. Simulation can proceed year by year for as long a period as desired. In the present study we have conducted the simulation over the period of 1980-2025; this simulation period has been selected for the reason that any longer time period seems to have little relevance to national planning, and that most of the population projections currently available in Japan cover the time period up to 2025.

It should be noted that both economic and social security submodels are simultaneous equation systems. In terms of the computer algorithm, we have employed the Jacobi Method for converging the submodels. The mathematical description of this method is found in Appendix A. Although we have attempted to use alternative methods such as the Gauss-Seidal Method, we have found that these alternative methods produced similar results, and that they have turned out to be more costly in computing time. For these reasons the simulation of the present study has been undertaken by the Jacobi Method alone.

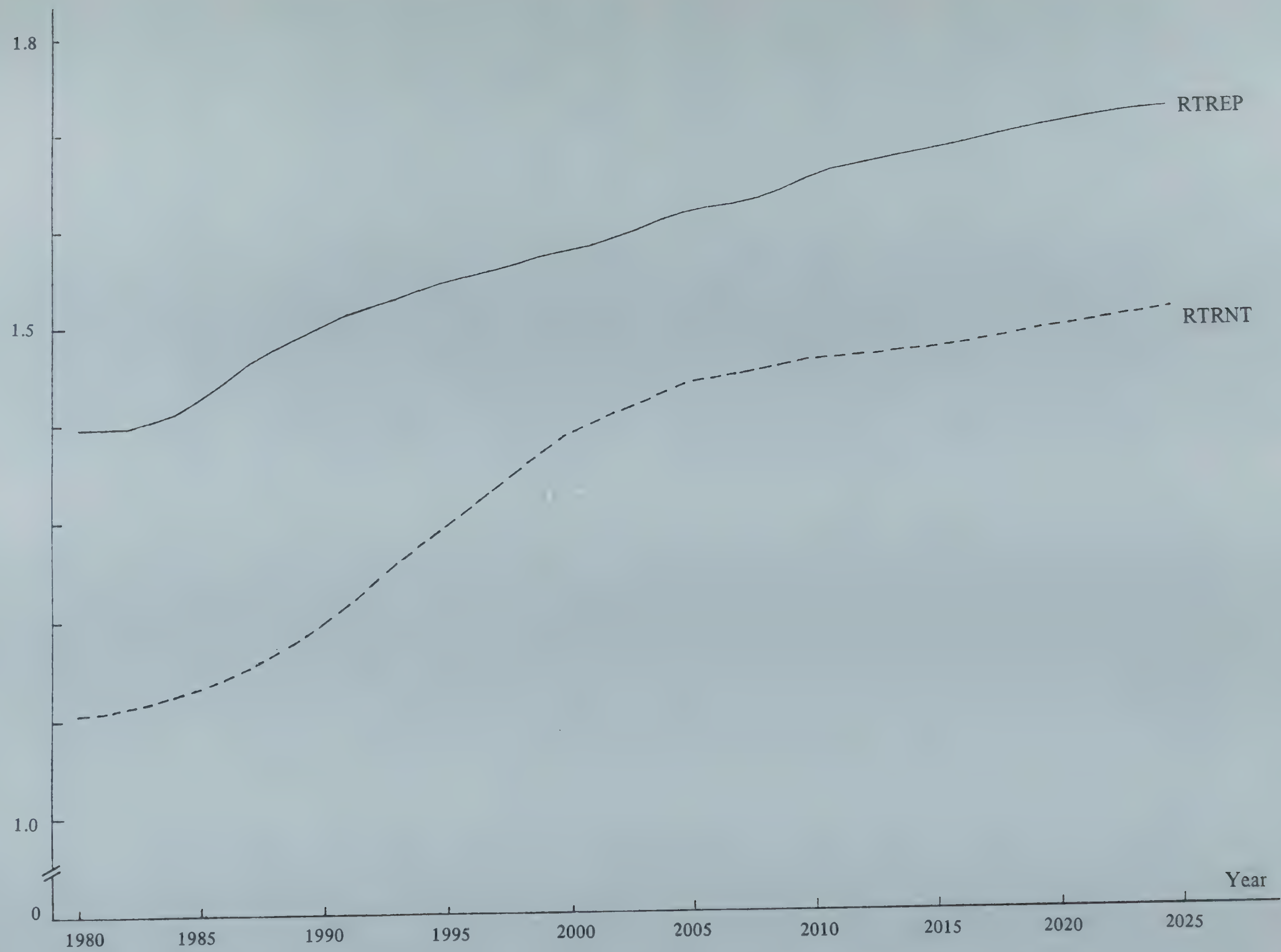


Figure XIV.2. Assumed changes in RTREP and RTRNT

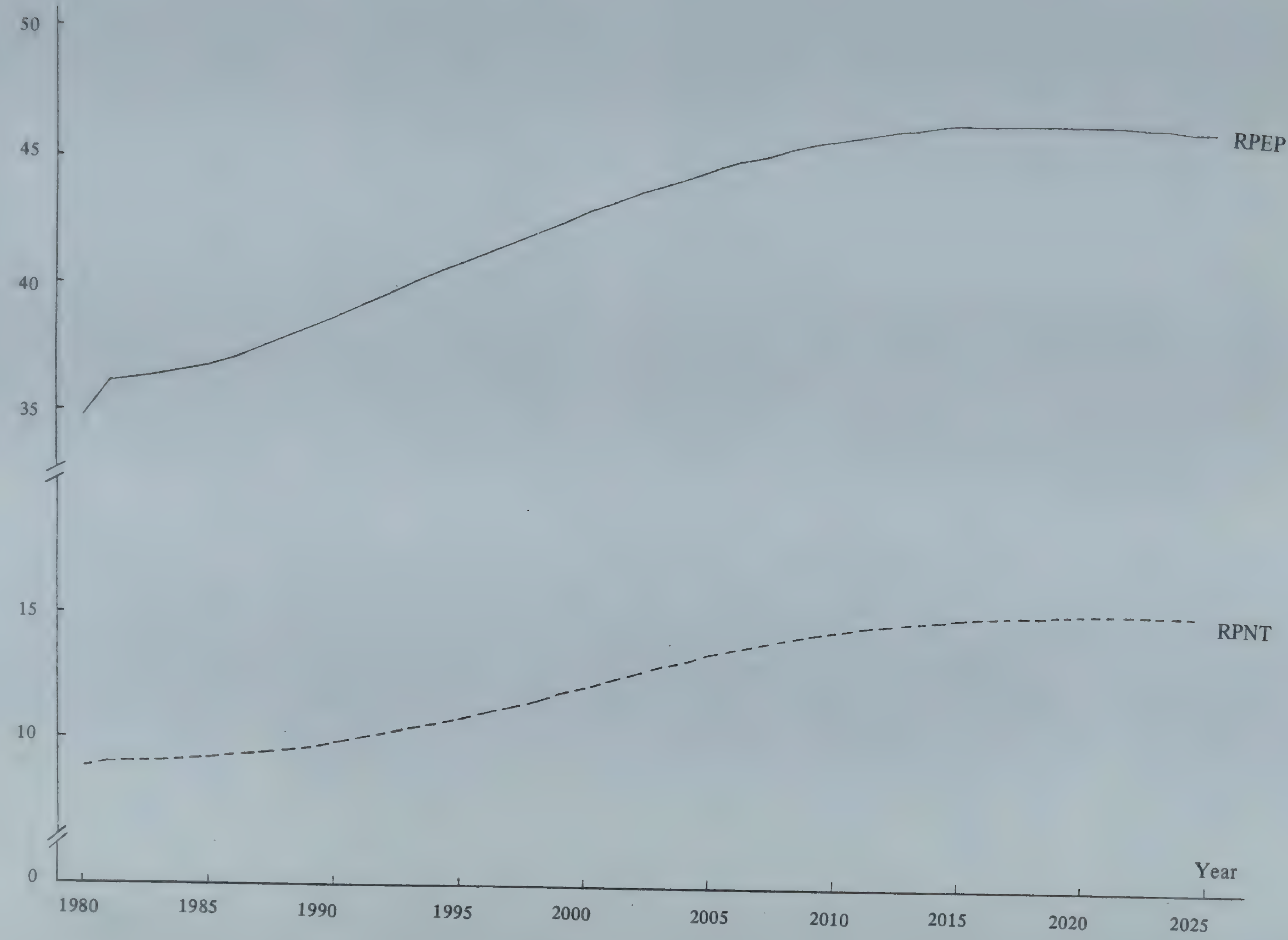


Figure XIV.3. Assumed changes in RPEP and RPNT

For purposes of illustration, we shall refer to the simulation based upon the above-mentioned computational conditions and assumptions as the "Standard Case." The simulation results of the standard case can be examined, on a submodel-by-submodel basis, in order of the demographic submodel, the economic submodel and the social security submodel. Subsequently, we will analyse alternative simulation experiments by highlighting major differences in results in comparison with the Standard Case.

B. STANDARD CASE

Table XIV.2. presents a simulated pattern of the total population, together with two other population projections, the Nihon University (NU) population projection prepared in 1978 and the projection published by the Ministry of Health and Welfare (MHW) in 1981. It should be stressed that unlike the Standard Case, these two population projections assumed both fertility and mortality changes exogenously. Because these two population projections have been fully described elsewhere [31] [23], we will confine ourselves to comparing the growth pattern of the Standard Case with that of the medium variant of each of these population projections. The pattern of the projected population by age and sex is shown in Appendix B. One can note that over the whole time period the population size of the Standard Case is constantly larger than that of the NU projection, and that this differential becomes increasingly pronounced. As compared to the 1981 NHW population projection, the Standard Case yields a slightly larger population up to the period of 2015-2020. In the 2020s the 1981 MHW population projection shows a bigger population size than the Standard Case. Furthermore, the NU projection reaches its peak value of 128.4 million persons in 2006, while the 1981 MHW population projection, 130.6 million in 2008. As opposed to these population projections, the Standard Case reaches its peak in 2007 with a total of 131.3 million persons.

These different population growth patterns are based upon different changes in both fertility and mortality. Figure XIV.4. and XIV.6. illustrate variations in TFR and life expectancy at birth for males and females, respectively. (Note that all the graphs of the NU and the MHW population projections are based upon the value of a 5-year interval after the year 2000, while the demographic changes of the Standards Case are plotted on the basis of annual values.) The fertility rate for the Standard Case fluctuates noticeably in the first two decades, while that for the NU projection declines linearly up to the year 2025. In the early part of the next century the former is exceeded by the latter. It should be stressed, however, that both cases show similar trends, namely declining fertility paths. In contrast to these cases, the MHW population projection assumes a falling fertility path up to 1985, which is followed by continuously rising fertility for the rest of the time period in question. In the year 2025, the NU projection assumes a TFR of 1.65 and the MHW projection, 2.088; the Standard Case shows a TFR of 1.704 in the corresponding year.

Table XIV.2. Total population size of three different population projections*

(unit: thousand)

Year	Standard Case	NU Projection	1981 MHW Projection
1980	117 060	116 838	116 916
1985	120 757	120 131	120 301
1990	123 752	122 549	122 834
1995	126 693	124 832	125 383
2000	129 480	127 104	128 119
2005	131 110	128 383	130 008
2010	131 009	127 894	130 276
2015	129 507	125 955	129 332
2020	127 316	123 345	128 115
2025	124 904	120 586	127 184

* Each of these population projections has been prepared on the basis of different base populations. The Standard Case has drawn upon the final count of the 1980 Census population; the NU projection has used the 1975 Census population; and the MHW projection has been based upon the preliminary, per cent sample of the 1980 Census population.

As discussed in Chapter III, one of the primary determinants of TFR is the age at first marriage for women (AFM). Figure XIV.5. depicts simulated changes in AFM. One can note that women's age at first marriage cycles with an interval of approximately 25 years. The amplitude of this cycle is 0.38 year, i.e., from 24.91 to 25.29 years of age. The reason for this modest amplitude is that the determinants of AFM, $ENROL^f$ and CRATIO tend to more oppositely, thus cancelling out each other's effect.

Except for the first few years the Standard Case shows the highest life expectancy at birth for both sexes among these three population projections. In both

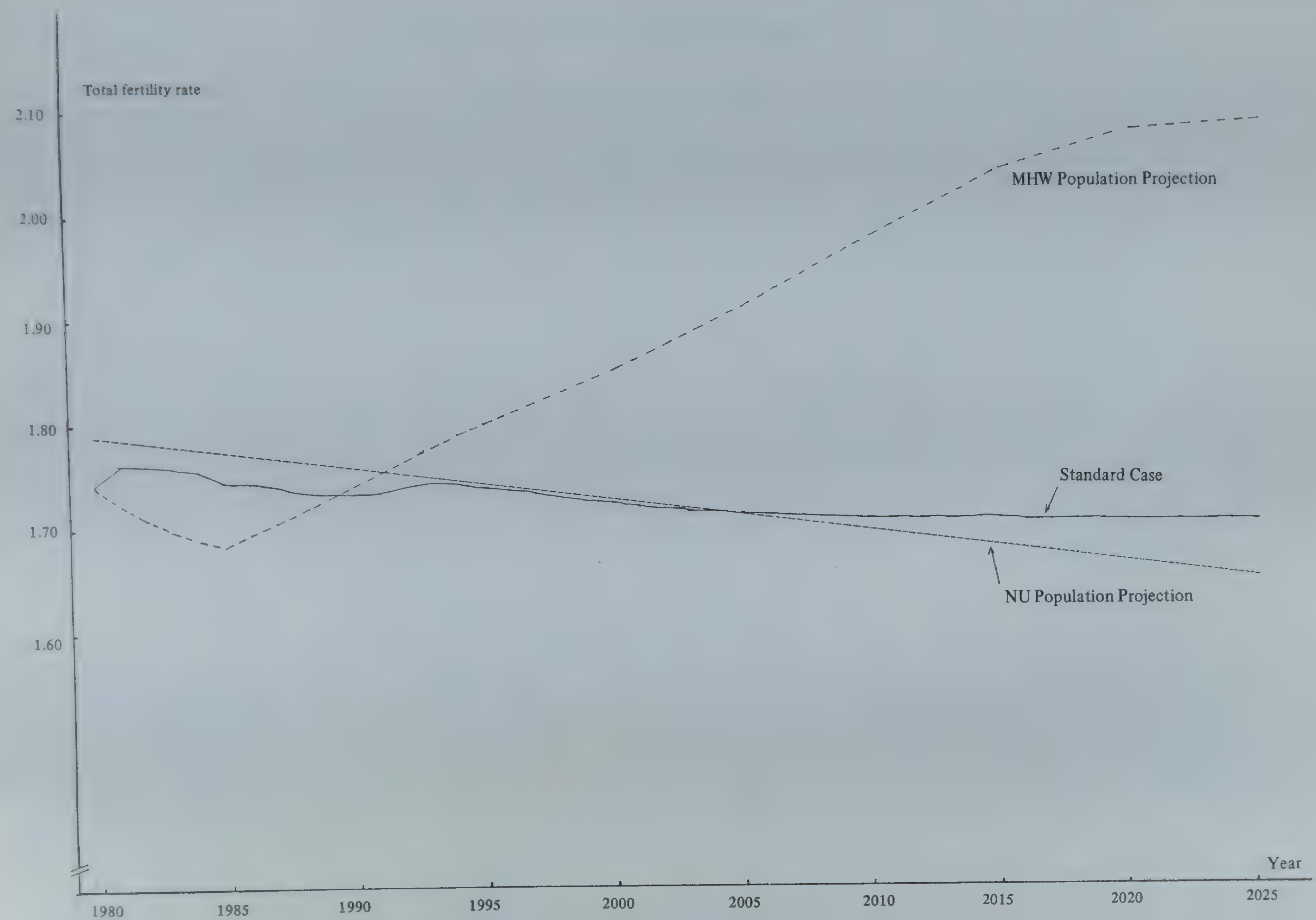


Figure XIV.4. Variation in total fertility rates of three different population growth paths

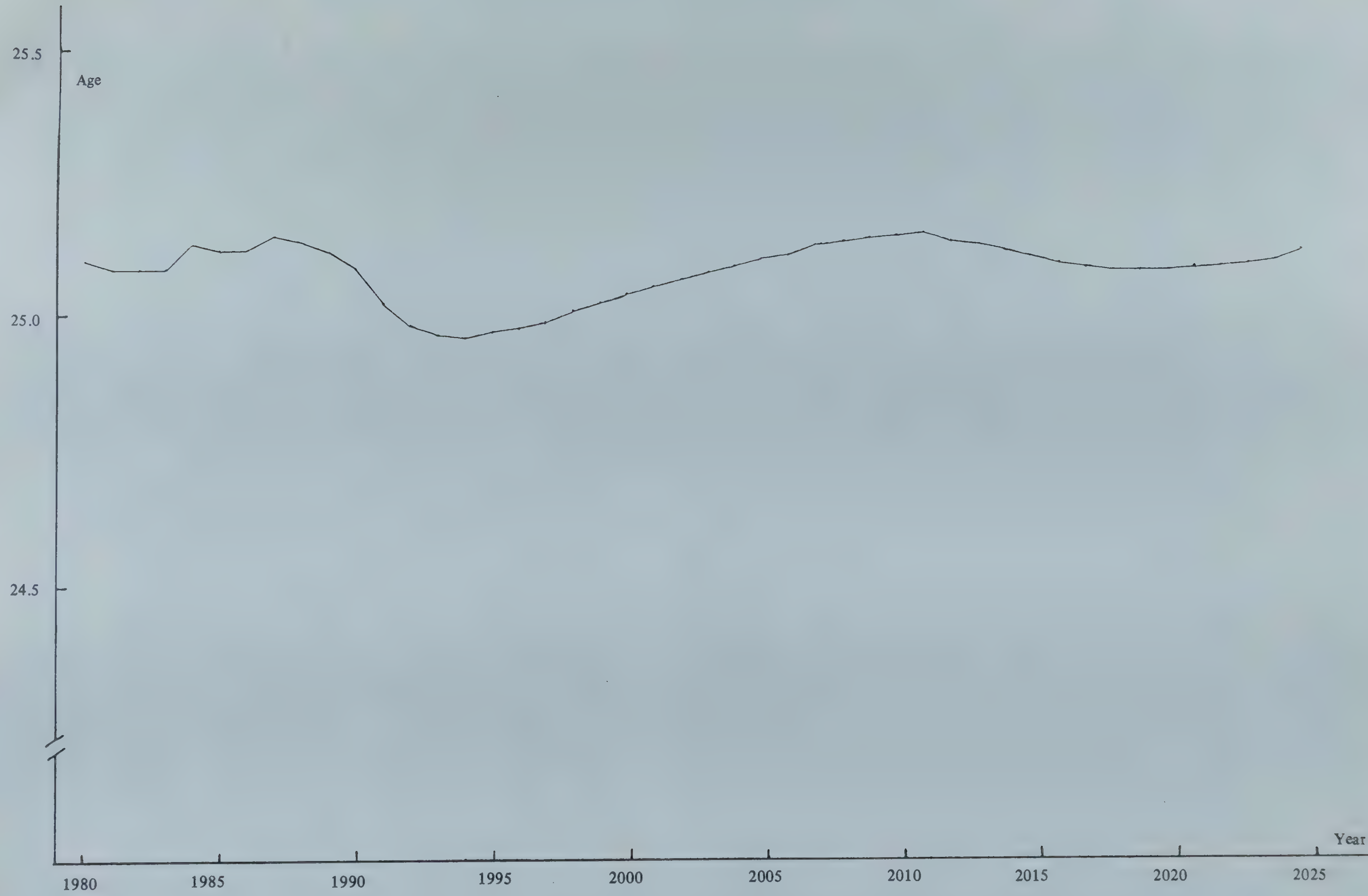


Figure XIV.5. Changes in female age at first marriage

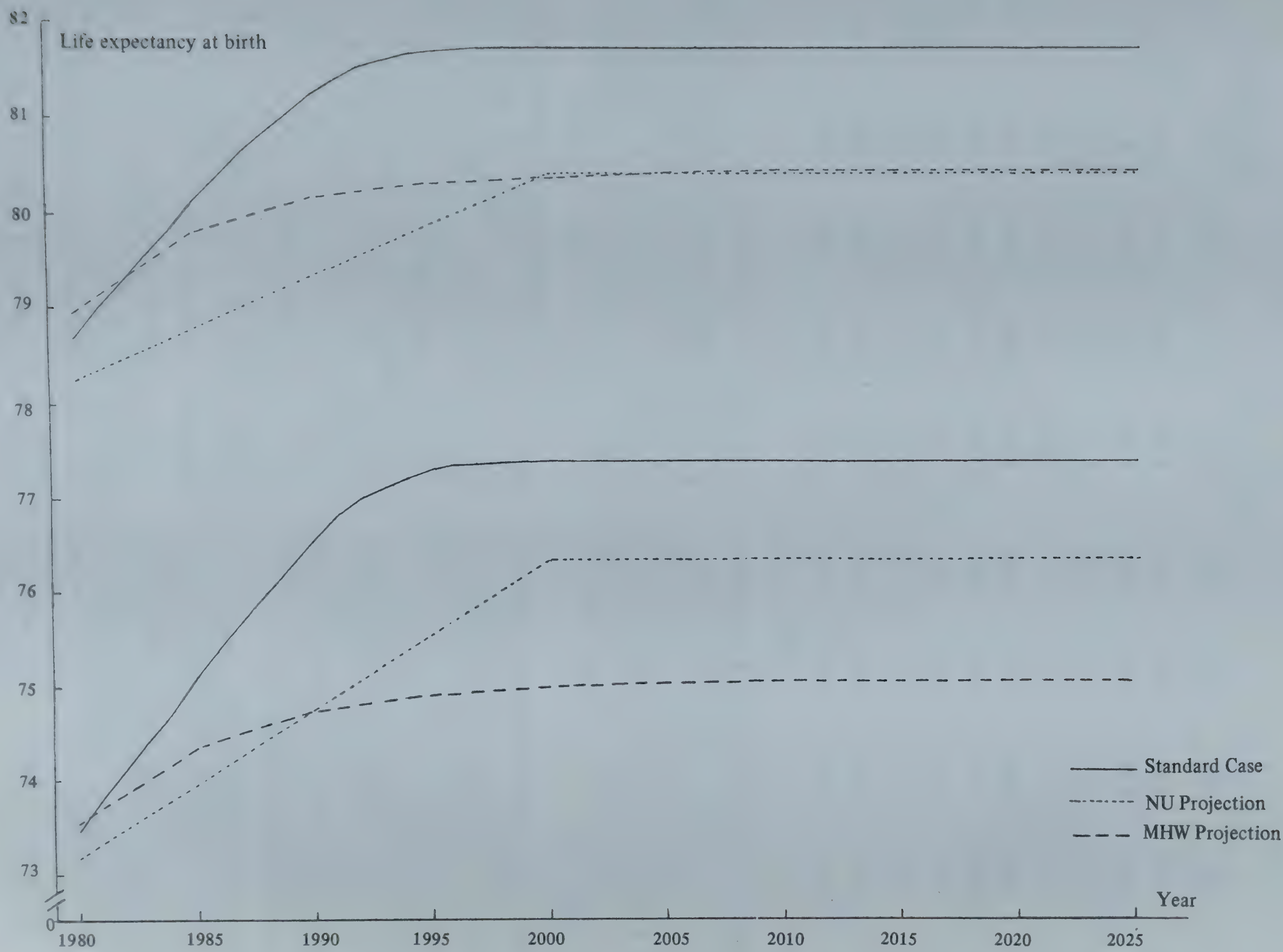


Figure XIV.6. Mortality changes among three population growth paths

Table XIV.3. Selected vital rates of three population paths

(unit: per 1,000 persons)

Year	Standard Case			NU Projection			MHW Projection		
	CBR	CDR	RNI	CBR	CDR	RNI	CBR	CDR	RNI
1980	13.34	6.16	7.18	13.57	6.84	6.91	13.57	6.22	7.35
1985	11.65	6.42	5.23	11.80	7.39	4.41	12.18	6.70	5.48
1990	11.47	6.82	4.65	11.40	7.99	3.41	12.34	7.43	4.91
1995	12.26	7.59	4.67	11.99	8.66	3.33	13.69	8.28	5.41
2000	12.10	8.61	3.49	11.98	9.30	2.68	14.35	9.16	5.20
2005	10.67	9.77	0.90	10.73	10.39	0.34	13.09	10.11	2.99
2010	9.47	11.07	–1.60	9.51	11.86	–2.34	11.98	11.18	0.80
2015	9.15	12.29	–3.14	9.10	13.26	–4.16	12.12	12.17	–0.05
2020	9.64	13.33	–3.69	9.49	14.35	–4.86	13.28	12.93	0.35
2025	10.10	14.22	–4.12	9.96	15.13	–5.18	14.41	13.35	1.06

the Standard Case and the NU projection, the mortality differential by sex shrinks considerably over time; in the former case it decreases from 5.22 to 4.3 years over the simulation period, and in the latter case it falls from 5.26 to 4.04 years over the period of 1977-2025. In the case of the MHW population projection, it becomes slightly smaller from 5.42 to 5.34 years during the period of 1980-2025.

Table XIV.3. summarizes changes in other vital rates of the three population paths. The crude birth rates (CBRs) of the Standard Case and the NU projection are considerably lower than the CBR of the MHW projection, particularly in the next century. On the other hand, the former two cases have higher crude death rates (CDRs) than those of the latter case. In terms of the rates of natural increase (RNI), therefore, the former two paths plunge into negative levels during the last two decades of the simulation period while the latter case barely undergoes a negative rate.

These different population growth paths produce different levels of population aging. Figure XIV.7. presents changes in the proportion of those aged 65 and over to the total population for these population growth paths. As opposed to the MHW population projection, the Standard Case produces a substantially higher proportion of the aged population. The Standard Case has the largest proportion of the aged population (23.88 per cent) in 2021, while the MHW projection reaches its peak value of 21.82 per cent in 2020, and the NU projection, 21.50 per cent in the same year. According to the recent estimate prepared by the United Nations Population Division, Luxemburg will have the world's highest aging level around the year 2025. However, the computed result of this study shows that Japan's aging level of 23.88 per cent in 2021 will be very likely to be the highest ever in the history of mankind.

These three population growth paths, however, show a somewhat different picture of the aging process in terms of the index of population aging which represents the ratio of the aged population (65 years old and over) to the young population (0-14 years old). As indicated in Figure XIV.8., the Standard Case dominates the MHW projection throughout the simulation period, and the differential expands at an increasing rate as years go by. This can be attributed to the fact that the MHW projection is based upon the 1 per cent sample of the 1980 Population Census and assumes lower survival rates and higher fertility levels. In the first half of the simulation period the index of aging for the MHW projection is higher than that for the NU projection. This pattern, however, is reversed in the second half.

Figure XIV.9. illustrates changes in the total dependency ratio. All of these population growth paths show a declining dependency ratio in the next decade or so; the Standard Case reaches its trough of the total dependency ratio in 1990, the NU projection, in 1991, and the MHW projection, in 1990. The values of these troughs are quite close to each other within the range of

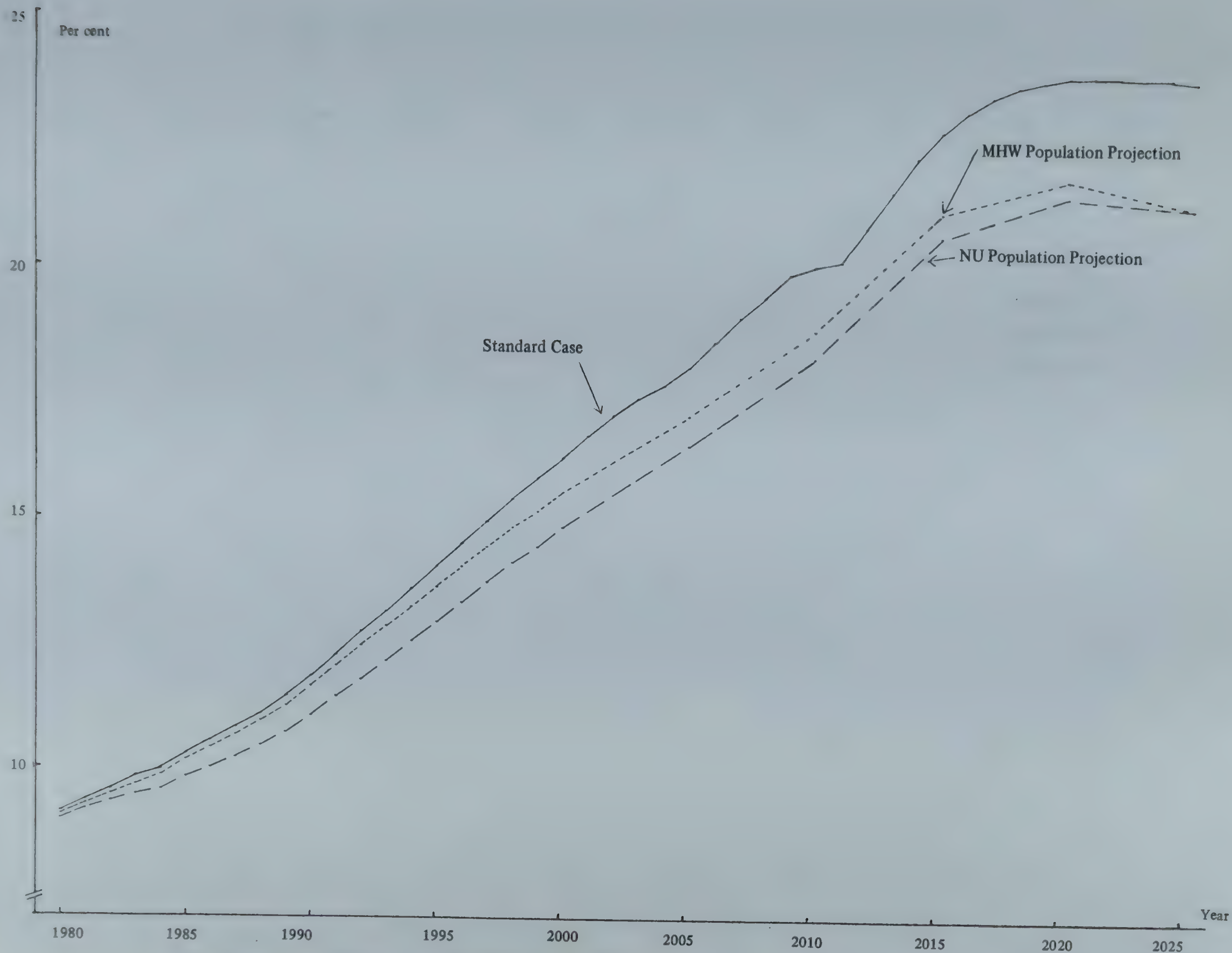


Figure XIV.7. Comparison of the percentage of those aged 65 and over among three different population growth paths

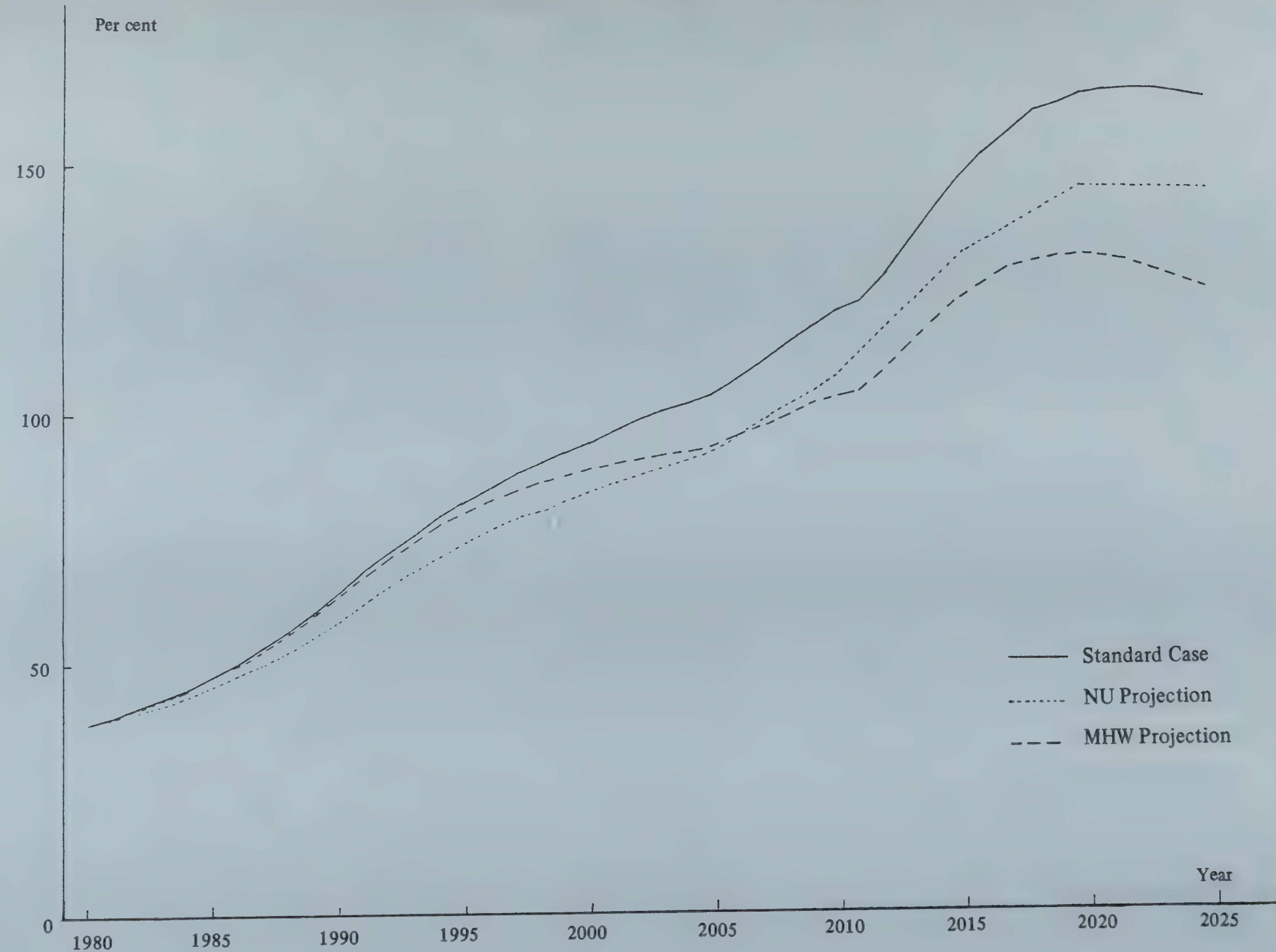


Figure XIV.8. Comparison of index of aging among three different population growth paths

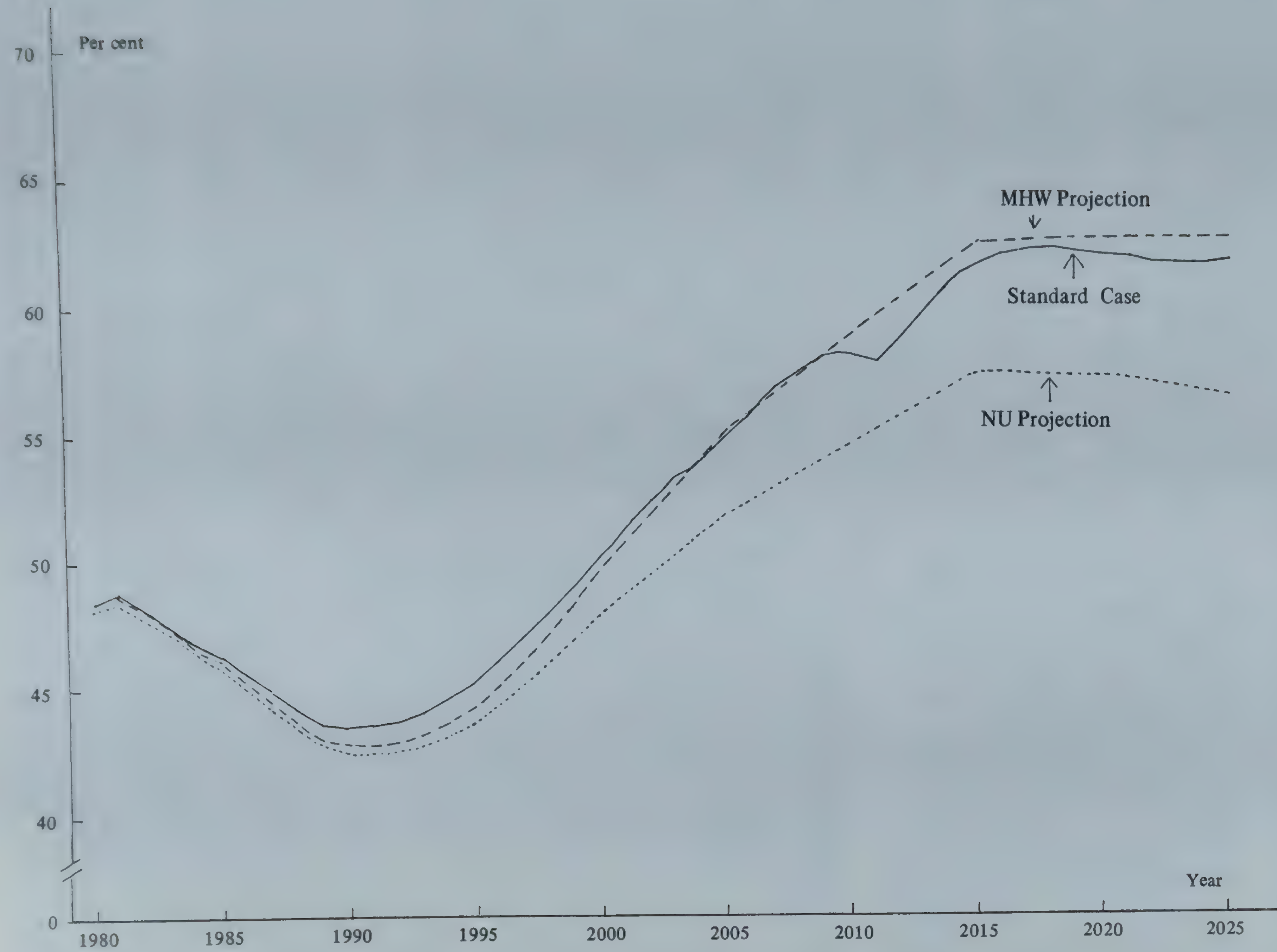


Figure XIV.9. Changes in the dependency ratio among three population growth paths

42.47 to 43.44 per cent. In the next century, however, the MHW projection shows a substantially higher value of the total dependency ratio, compared to other population growth paths. Over the period of 2020-2025, it increases to a level of 62.69 per cent. In contrast, the Standard Case reaches its peak value of 62.49 per cent in 2018, and for the NU projection, 57.52 per cent in 2015.

Another demographic endogenous variable included in the population submodel is the average household size (HS). The simulated pattern has been presented in Column (1) of Table XIV.4. The value of HS falls fairly quickly in the next two decades, and continues to decline at a slower tempo in the next century. By dividing the total population by the average household size, one can obtain the growth pattern of the number of households, as indicated in Column (2) of Table XIV.4. While the average household size decreases continuously, the number of household reaches its peak (47,600,781 households) in the year of 2012, and declines thereafter.

Table XIV.4. Simulated values of the average household size and the number of households

Year	Average Household Size (persons)	Number of Households ('000)
1980	3.22	36 308
1985	3.08	39 155
1990	2.98	41 580
1995	2.89	43 781
2000	2.83	45 685
2005	2.79	47 003
2010	2.75	47 568
2015	2.73	47 515
2020	2.70	47 148
2025	2.68	46 649

Now we examine changes in labour force participation rates for various age groups for both sexes. In Figure XIV.10. simulated values for males are described by solid lines and dotted lines for females. Both $LFPR^{f1}$ and $LFPR^{m1}$ oscillate considerably, reflecting changes in the educational enrolment rates for both sexes. Although $LFPR^{m3}$ rises initially due to an increasing proportion of the aged population, $LFPR^{m3}$ continuously falls as a result of rising *per capita* pension benefits, and $LFPR^{f3}$, mostly due to a decline in the proportion of self-employed workers to a total of those employed in economic activities. Labour force participation rates for other age groups for each sex remain unchanged, as explained earlier in Chapter III. Each of these labour force participation rates is multiplied by the population size of the corresponding age and sex so as to obtain the age-sex-specific labour force size. The computed results are listed in Table XIV.5. Note that because of low fertility the growth of the labour supply continues to fall until the year 1998, after which it begins to be negative.

In the above, we have analysed simulated patterns of changes in demographic variables. We will now consider simulated results of the economic variables incorporated in the economic submodel.

Let us first consider the production side of the economic component. Table XIV. 6. contains simulated changes in GNPR, GNPN, and *per capita* GNPR. All of these variables undergo a monotonically increasing trend. During the simulation period, GNPR expands 3.90 times its size. Similarly, *per capita* real GNP (GNPR/POP) expands 3.65 times, as shown in Column (2) of Table XIV.6. As clearly indicated by Figure XIV. 11. after oscillating between 5 and 6 per cent levels for the first several years GNPR starts growing at a much slower pace. In 2025, the rate of growth of GNPR becomes as low as 1.44 per cent per annum. In terms of *per capita* GNPR its annual growth rate is lower than that of GNPR up to the year 2007, but the former becomes greater than the latter for the rest of the simulation period. The principal source for this cross-over of annual growth rates is the shrinking total population size. That is, although the growth of GNPR continues to decline in the early part of next century, the total population size substantially decreases, thus decelerating the slow-down of *per capita* GNPR.

In Column (3) of Table XIV.6. changes in nominal GNP are listed. The growth of GNPN over the period of 1980-2025 is of the order of 21.63 times. The simulation result shows that GNPN continues to grow at an annual rate of approximately 6 to 8 per cent toward the end of the 2010s. This inflationary trend slightly eases off in the 2020s.

One may conclude from these simulated results that the future scenario of the Standard Case can be characterized by the continuous economic slow-down. This gloomy perspective can be attributed largely to a slowing growth of the labour force. As we have already analysed changes in the labour supply side in connection

Table XIV.5 Simulated value of the labour force by age and sex

(unit: thousand persons)

Year	Total Labour Force	Male			Female			
		15-24 years old	25-59 years old	60+ years old	15-24 years old	25-44 years old	45-54 years old	55+ years old
1980	56 500	3 494	27 789	3 343	3 459	10 158	4 767	3 492
1985	58 938	3 645	28 972	4 018	3 425	9 630	4 943	4 305
1990	61 551	4 248	29 397	4 893	3 677	9 319	5 244	4 772
1995	63 534	4 776	29 827	5 584	3 649	8 798	5 927	4 973
2000	63 661	3 965	30 694	6 012	2 985	9 005	5 847	5 153
2005	62 343	3 296	30 412	6 382	2 556	9 140	4 969	5 589
2010	60 280	3 087	28 853	6 985	2 556	8 894	4 704	5 301
2015	58 926	3 335	27 903	6 601	2 590	8 370	4 991	5 136
2020	58 726	3 658	27 671	6 229	2 650	7 669	5 491	5 357
2025	57 846	3 432	27 461	6 049	2 403	7 494	5 353	5 654

Table XIV.6. Simulated values of GNPR, GNPN and *per capita* GNPR

Year	(1) GNPR (trillions of yen)	(2) GNPR/POP (millions of yen)	(3) GNPN (trillions of yen)
1980	193.70	1.655	237.19
1985	255.01	2.112	352.79
1990	325.05	2.627	521.78
1995	399.49	3 153	751.58
2000	473.39	3.656	1 075.68
2005	542.50	4.138	1 544.22
2010	602.66	4.600	2 280.13
2015	655.32	5.060	3 266.15
2020	704.02	5.530	4 184.80
2025	755.19	6.046	5 132.69

with the labour force participation rates, as described in Table XIV.5. we will now turn to labour demand. As presented in Column (1) of Table XIV.7. the labour demand (LD) shows a similar pattern. Due to the economic slow-down, the demand for labour does not grow as rapidly as before, and starts to decrease from the year 1999. The labour demand marks its peak value of 63.844 million workers in 1998.

By definition, the difference between the demand for labour and the supply of labour is unemployment. As indicated in Column (2) of Table XIV.7. the number of those unemployed (UN) fluctuates considerably from time to time. The lowest level of unemployment is 1.153 million persons in 2011, while the highest one, 1.386 million persons in 1995. These changes in unemployment largely contribute to the determination of nominal wages (WAGE). The nominal wage for the average employee rises of the order of magnitude of 22.20 times over the simulation period. (Refer to Column (4) of Table XIV. 7. The number of employees (LW) increases gradually up to the year 2005, and it decreases continuously for the remaining period of simulation, as shown in Column (3) of the same table.

Another crucial variable related to labour is the number of hours worked by the average worker, h. The simulated value of h has been plotted in Figure XIV.12. Because h is a function of CPD and WAGE, and both CPD and WAGE rise continuously as shown in Table XIV.7. and Figure XIV.14, h falls substantially in the next several decades.

In what follows, we examine selected variables representing the capital side. Capital stock (KP), which is another major input of the production function,

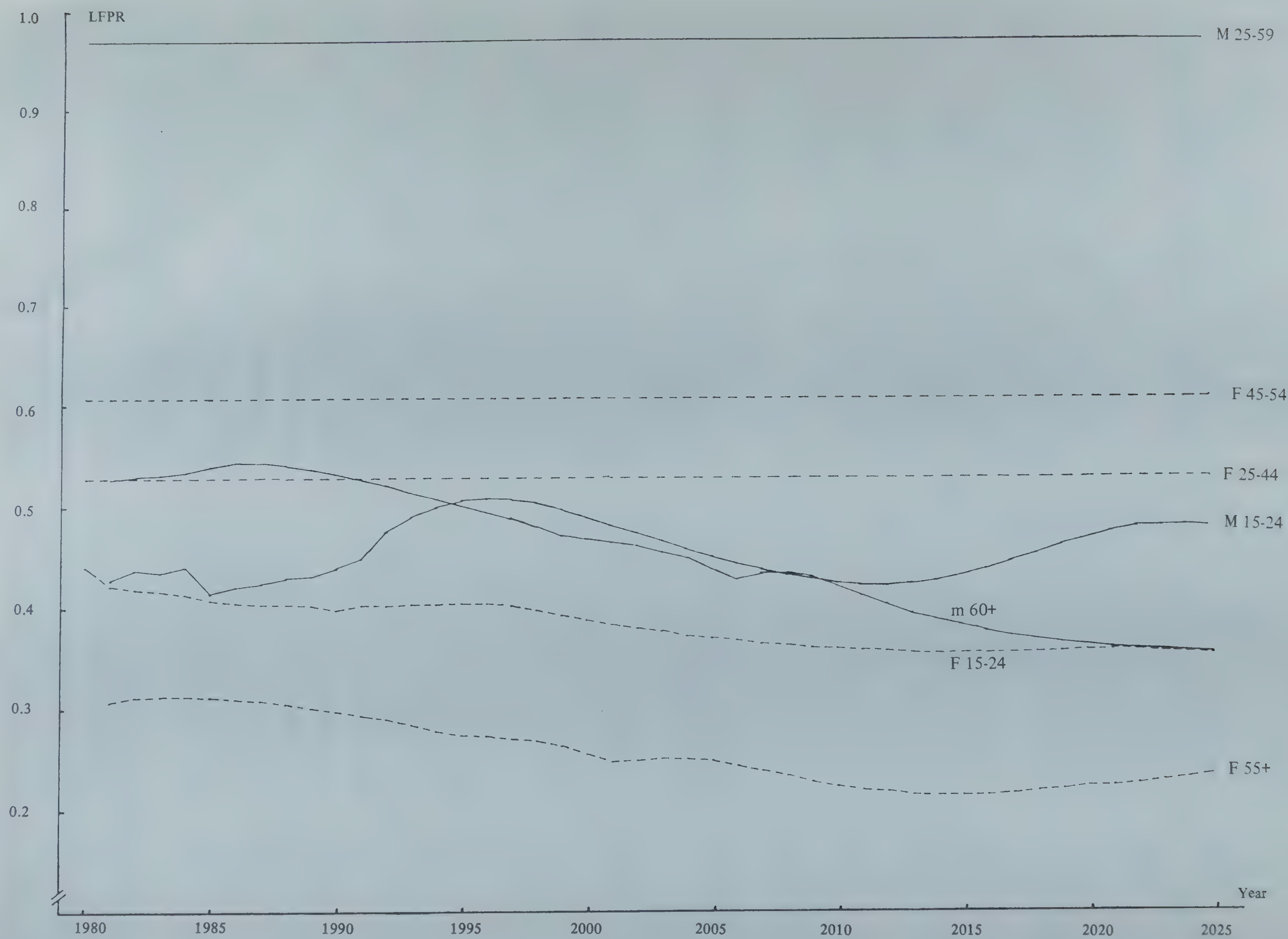


Figure XIV.10. Simulated values of labour force participation rates for various age groups for each sex

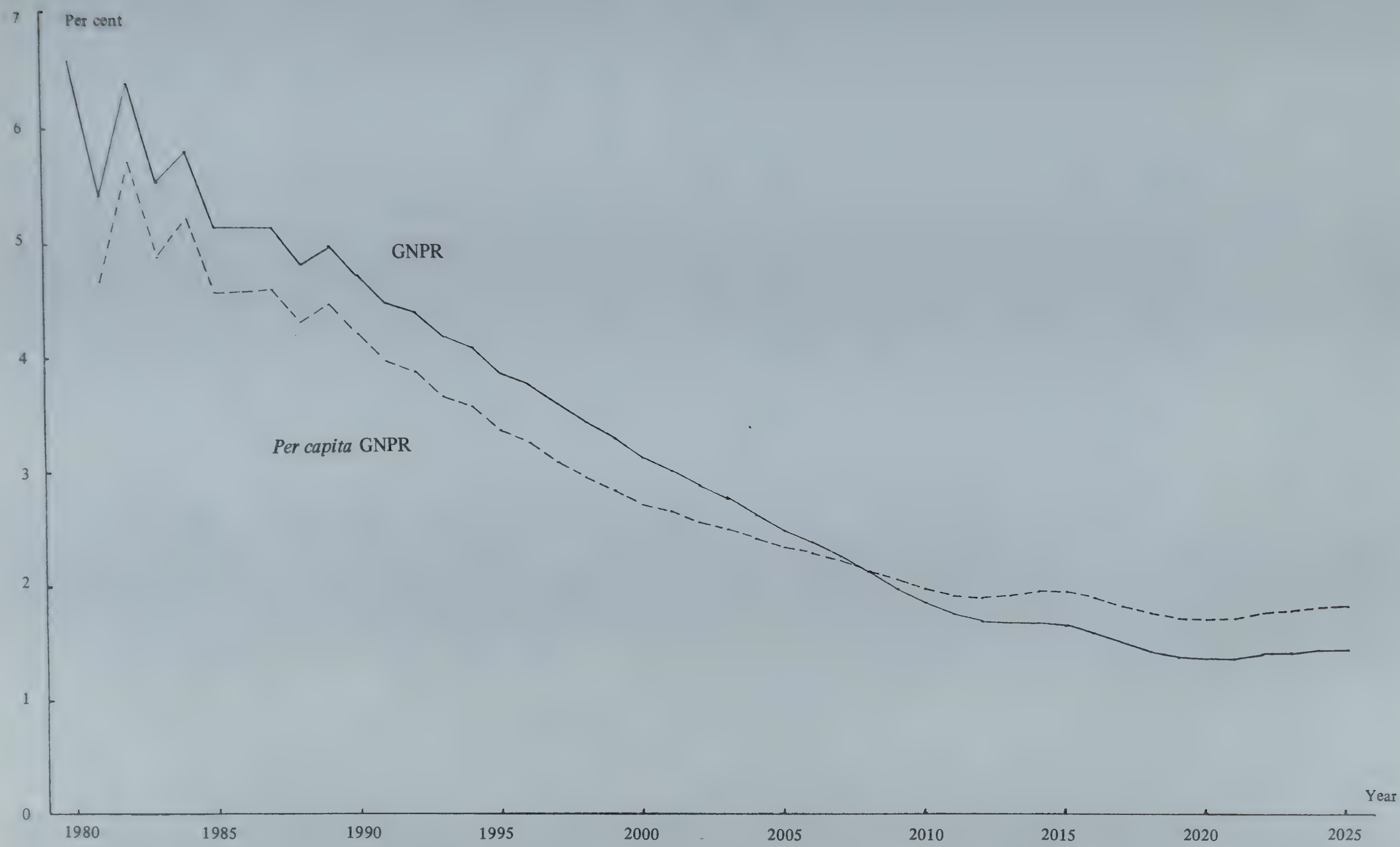


Figure XIV.11. Simulated growth rates of GNPR and *per capita* GNPR

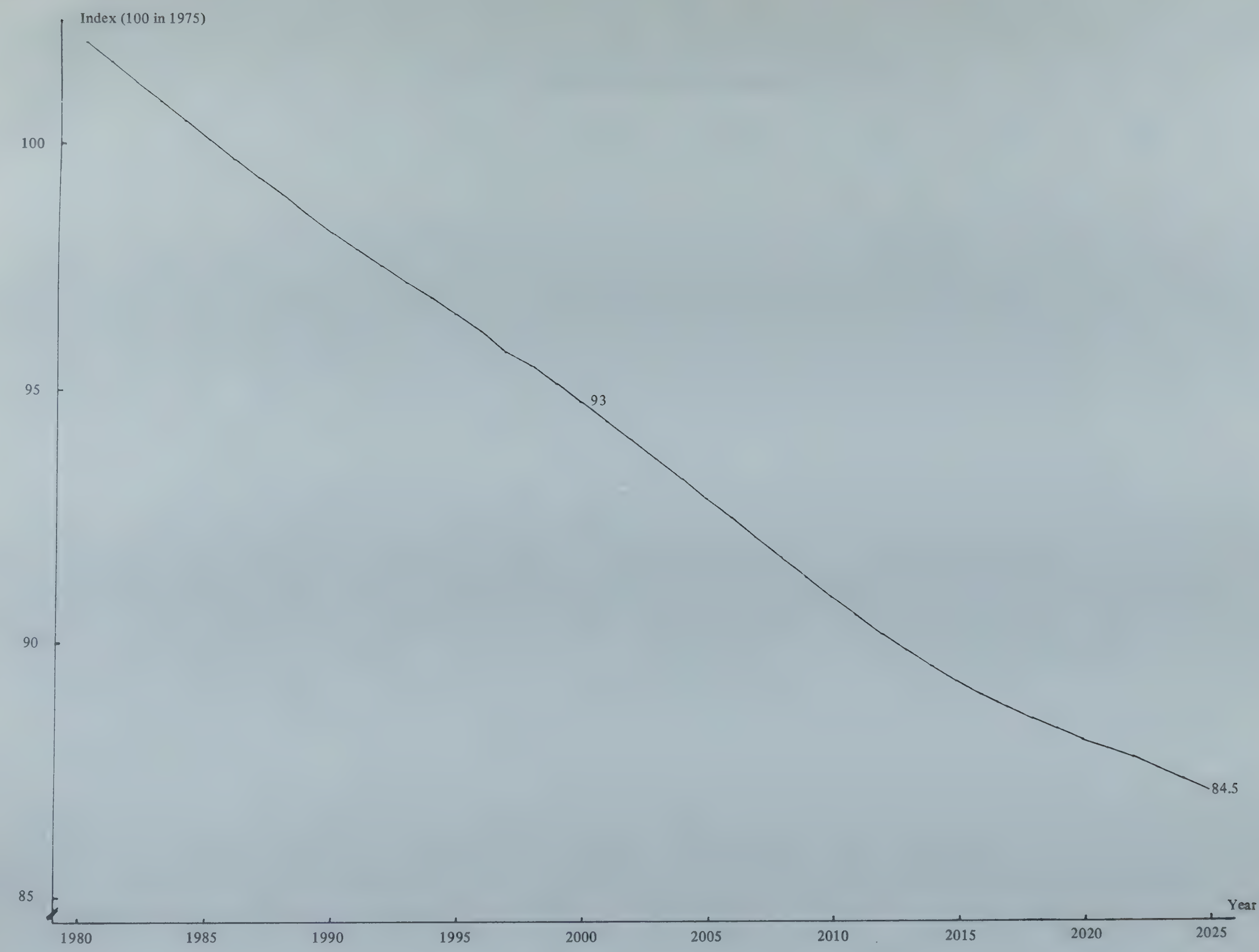


Figure XIV.12. Simulated value of the index of hours worked per worker

Table XIV.7. Simulated values of labour market-related variables – LD, UN, LW and WAGE

Year	(1) LD (thousand persons)	(2) UN (thousand persons)	(3) LW (thousand persons)	(4) WAGE (millions of yen)
1980	55 192	1 308	39 228	2.97
1985	57 695	1 243	42 957	3.91
1990	60 229	1 322	46 700	5.28
1995	62 148	1 386	50 156	7.15
2000	62 348	1 313	52 292	10.10
2005	61 129	1 215	52 364	15.16
2010	59 124	1 156	50 673	24.49
2015	57 699	1 227	48 377	38.55
2020	57 370	1 356	46 999	52.07
2025	56 544	1 303	45 981	66.01

increases very rapidly, as indicated in Column (1) of Table XIV.8. From 1980 to 2025 the value of KP increase by 7.7 times in real terms. It should be noted, however, that the growth of KP decelerates in the 21st century. This deceleration is caused by the changes in gross private investment and depreciation.

Column (2) of the same table shows fluctuations in the amount of private investment (IPR) as measured in 1975 constant prices. The level of IPR rises continuously from 31.95 to 121.57 trillion yen over the period of 1980-2025. In the next century, however, the growth of IPR falls as a result of slowing economic growth. Depreciation (DEP), which is in nominal terms, continuously increases throughout the simulation period. The annual rate of its change, however, decreases considerably in the next century as a consequence of slower capital formation. Furthermore, depreciation in real terms (DEP/ID) grows less rapidly than that in nominal terms, especially in the early part of the next century, as shown in Column (4) of Table XIV.8.

Table XIV.8. Simulated values of capital-related variables – KP, IPR, DEP

(unit: trillions of yen)

Year	(1) KP	(2) IPR	(3) DEP	(4) DEP/ID
1980	283.4	31.95	31.56	28.29
1985	394.8	43.91	46.28	38.68
1990	539.3	56.76	69.14	52.78
1995	719.9	70.19	102.37	70.59
2000	930.9	82.92	149.50	91.15
2005	1 165.3	94.18	217.52	114.17
2010	1 411.0	101.85	320.14	138.45
2015	1 659.2	107.76	458.45	164.08
2020	1 904.7	112.13	605.77	191.97
2025	2 168.9	121.57	753.95	218.97

Table XIV.9. indicates the growth pattern of gross savings (S) which is the source of these investment activities and capital accumulation. Gross savings in both nominal and real terms (S and S/ID) continue to expand throughout the simulation period, though the magnitude of each variable differs considerably. Over the period of 1980-2025, the amount of S expands by 11.85 times, and that of S/ID, by 3.86 times. More importantly, both personal savings (SP) and corporate savings (SC) increase continuously, though their growth rates decline considerably in the next century. On the other hand, government savings (SG) increase slowly up to the year 1993, after which they decrease rapidly, these becoming negative in the early next century. The souces of such negative SG are rising taxes and contributions to social security programmes.

Table XIV.10. presents the growth pattern of disposable income (YD) and various tax revenues. Over

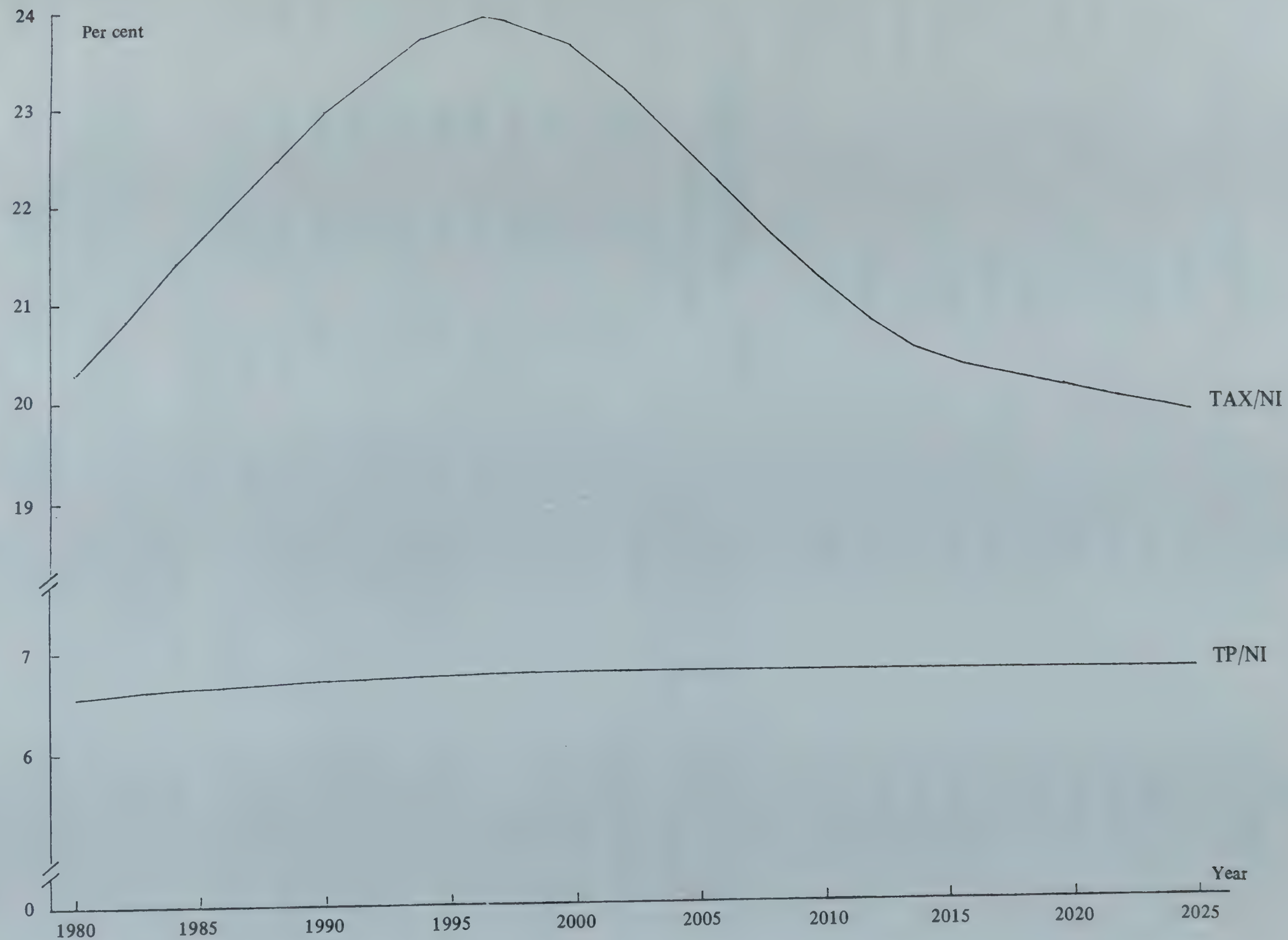


Figure XIV.13. Changes in the burden of taxes in terms of national income

Table XIV.9. Simulated values of savings-related variables – S, SP, SC, SG

(unit: trillions of yen)

Year	(1) S/ID	(2) S	(3) SP	(4) SC	(5) SG
1980	72.4	80.7	3.80	5.17	16.29
1985	96.0	114.8	45.79	9.34	20.14
1990	124.5	163.1	64.83	14.86	22.94
1995	156.2	226.5	87.05	21.11	23.02
2000	181.6	297.7	113.95	27.62	14.11
2005	200.3	381.5	148.55	30.03	–4.49
2010	220.5	509.9	191.59	31.56	–26.43
2015	231.6	647.3	223.45	32.43	–53.86
2020	251.5	794.4	243.94	35.89	–94.31
2025	278.0	958.8	273.64	42.22	–138.70

Table XIV.10. Simulated values of disposable income and various taxes

(unit: trillions of yen)

Year	YD	TAX	TP	TC	TI
1980	165.9	41.9	13.6	10.9	17.4
1985	243.6	65.8	19.9	20.5	25.3
1990	375.4	100.4	29.2	34.3	36.9
1995	518.2	145.5	42.0	50.9	52.7
2000	758.6	203.9	59.9	69.1	75.0
2005	1 119.3	295.4	89.9	93.1	112.3
2010	1 674.1	425.3	136.9	117.9	170.6
2015	2 423.2	599.9	201.3	148.0	250.7
2020	3 100.2	768.9	260.7	183.7	324.5
2025	3 778.3	938.7	318.0	225.1	395.6

the simulation period, YD expands to the magnitude of 22.78 times and TAX (total tax revenues), 22.40 times. Figure XIV.13. illustrates changes in the ratio of TAX to national income (NI), and that of TP to NI. Although the former oscillates considerably from 21.90 per cent in 1980 to 24.02 per cent in 1994, it remains, by and large, fairly stable. The latter also increases only slightly throughout the period under study. Interestingly enough, both personal taxes (TP) and indirect taxes (TI) increase rapidly while corporate taxes (TC) grow at a somewhat slower rate.

The slow growth of corporate taxes is attributable to the fact that the an increasing proportion of the aged workers increase the employers' contributions to social insurance schemes, thus reducing the growth of corporate income. Slower growth of corporate income, in turn, contributes to a slower growth of dividends, as shown in Table XIV.11.

Table XIV.11. Simulated values of corporate income, dividends, and employees' income

(unit: trillions of yen)

Year	YC	DIV	YW
1980	19.6	3.0	116.6
1985	35.4	5.2	167.9
1990	57.5	8.0	246.5
1995	83.6	11.2	358.7
2000	111.6	14.5	528.8
2005	141.6	18.0	793.9
2010	171.2	21.4	1 237.1
2015	206.3	25.3	1 851.7
2020	250.8	30.2	2 423.4
2025	304.3	36.0	3 002.5

We now turn to the demand side. Table XIV.12. describes the changing patterns of two different types of personal consumption, i.e., personal consumption of general goods (C1) and that of health-related goods (C2). In nominal terms, C1 rises by 20.59 times and C2, by 76.60 times. The main propellent of such large increases in personal consumption is a sustained growth of per capita GNP. More importantly, the differential in the magnitude of growth rates between these two types of personal consumption reflects the fact that due to population aging medically-related consumption increases at a faster rate. The same is true of both types of consumption in real terms (C1R and C2R).

Table XIV.13. presents some of the other demand components. (All the values included in this table are expressed in real terms.) Although the amount of inventory investment (JPR) oscillates considerably during the simulation period, it is, by and large, on the

Table XIV.12. Simulated patterns of two types of personal consumption

(unit: trillions of yen)

Year	(1) C1N	(2) C2N	(3) C1R	(4) C2R
1980	119.2	13.7	94.0	10.8
1985	176.2	22.4	122.7	15.6
1990	256.4	37.0	152.7	22.1
1995	364.6	67.4	182.6	33.8
2000	522.7	122.9	212.5	50.0
2005	761.7	210.1	241.4	66.6
2010	1 130.6	353.3	261.0	81.6
2015	1 599.3	601.8	271.2	102.4
2020	2 020.4	837.6	280.2	116.2
2025	2 454.5	1 052.4	293.7	125.9

Table XIV.13. Simulated values of selected demand components

(unit: trillions of yen)

Year	(1) JPR	(2) IGR	(3) CGR	(4) IHR
1980	4.73	11.82	10.56	31.71
1985	3.26	22.86	19.06	34.10
1990	3.76	35.59	27.38	37.71
1995	3.89	47.80	33.78	41.63
2000	3.87	59.08	37.65	42.40
2005	3.69	69.70	39.13	39.87
2010	3.27	82.85	39.43	37.11
2015	3.23	92.55	37.80	34.05
2020	2.98	103.02	38.89	33.55
2025	3.30	112.34	40.46	33.82

downward trend. The other demand component IGR, continues rising throughout the simulation period, but its growth rate is much lower in the next century, as compared with the first two decades. CGR, which is another demand component, increases continuously up to the 2010s, after which it starts fluctuating to a noticeable extent. Furthermore, IHR, which is a fourth demand component, shows a changing pattern quite comparable to that of CGR. The differences in the growth pattern of IGR, CGR and IHR lead to a changing relative size of each component. In 1980 the relative size of each of these components is 21.9, 19.5 and 58.6 per cent, respectively. In 2025, however, it is 60.2, 21.7 and 18.2 per cent.

Although both imports and exports are also demand components, the present model deals with them as the difference between them, (EXR-IMR), rather than looking at each individually. By assumption, however, this difference becomes zero, beginning from 1986.

The following seven deflators have been computed: CGD, CPD, C1D, GNPD, IGD, IPD, and ID. Figure XIV.14 displays the pattern of changes in each deflator. Although the value of each these deflators are determined by a similar set of variables, coefficient differs substantially with each deflator, there are vast differences in their values in the year 2025. CGD, for instance, expands 13.7 times. During the corresponding period, the value of ID rises by 3.1 times, IPD, by 3.2 times, IGD, by 5.5 times, GNPD, by 5.6 times, C1D, by 6.7 times, and CPD, by 6.7 times.

Economic and demographic changes have effects in the social security submodel. We will first analyse quantitative changes in selected variables for each programme included in the social security submodel and subsequently for the social security system as a whole. Programme-wise, we will consider public pension schemes and medical plans.

Table XIV.14 presents changes in some of the key factors of the Employees' Pension Scheme (EPPS) during the simulation period in question. Because of its increasing maturity and the growing proportion of the aged population, EPPS undergoes a rapid growth of its recipients (BFEP) from 1.99 to 11.76 million persons over the period of 1980-2025. At the same time, as a consequence of slowing but sustained economic growth, the amount of annual pension benefits received by each beneficiary (PCPNEP) rises from 1.03 to 30.06 million yen over the corresponding period. Due to these growth factors the total amount of EPPS benefits paid out (PNEP) grows by 174 times, namely from 2.06 to 359.21 trillion yen during the same time period.

These rapidly increasing benefits are financed by its working-age members (PIEP). The simulated pattern of the growth of PIEP is substantially different from that of these benefit factors. PIEP increases monotonically up to the year 2003, after which it falls continuously. This growth pattern closely coincides with that of the labour force, as has been examined earlier.

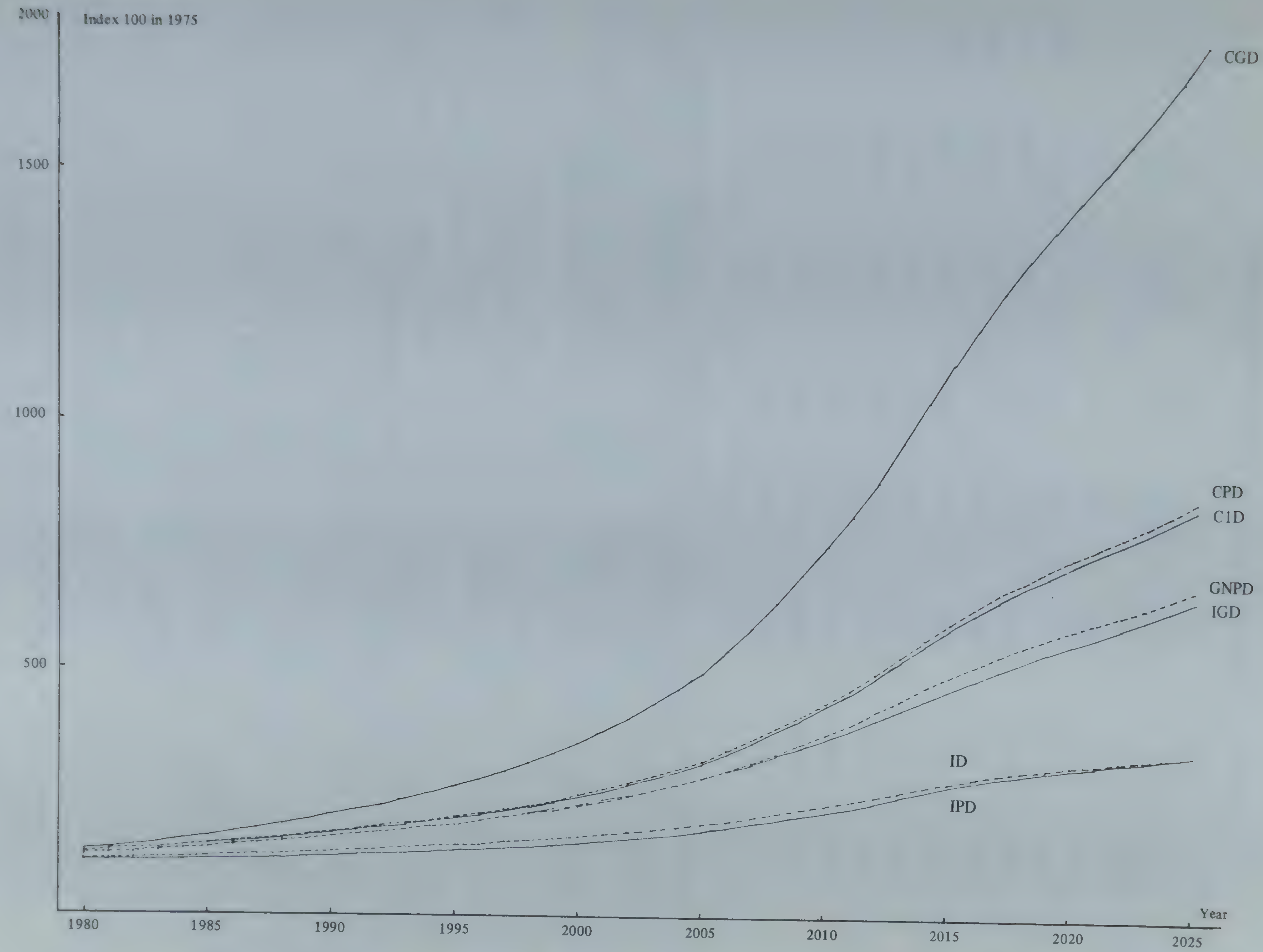


Figure XIV.14. Patterns of changes in various deflators

Table XIV.14. Changes in selected variables of the employees' pension scheme

Year	(1) BFEP (million persons)	(2) PNEP (trillions of yen)	(3) PCPNEP (millions of yen)	(4) PIEP (million persons)	(5) RSIEP (per cent)	(6) GSEP (trillions of yen)	(7) RFEP (trillions of yen)	(8) GAPEP (trillions of yen)
1980	1.992	2.06	1.032	25.574	10.6	0.50	28.7	4.334
1985	3.267	4.70	1.439	27.902	12.6	1.17	56.6	6.584
1990	4.614	9.43	2.045	30.240	14.6	2.47	97.3	9.170
1995	6.137	17.96	2.927	32.398	16.6	4.85	149.2	11.054
2000	7.672	33.29	4.339	33.732	18.6	9.16	203.7	10.211
2005	9.131	61.84	6.773	33.777	20.6	17.45	229.1	0
2010	10.462	117.42	11.223	32.721	28.6	33.82	229.1	0
2015	11.363	203.50	17.909	31.287	35.2	59.53	229.1	0
2020	11.681	282.85	24.215	30.427	38.5	84.06	229.1	0
2025	11.757	359.21	30.553	29.791	40.2	107.83	229.1	0

Through the interaction between the benefit and contribution sides, the required contribution rate (RSIEP) rises quite swiftly, particularly in the next century. The required amount of Government subsidies (GSEP) grows by 216 times. More importantly, the financing scheme of EPPS shifts from reserve-financing to PAYG-financing in the year of 2005. This change in the financing mechanism is reflected by no further growth of its accumulated reserve funds (RFEP) and the zero balance of its revenues and outlays (GAPEP) after 2005.

We now turn to the simulation results for the National Pension Scheme (NTPS). As indicated by Table XIV.15. NTPS undergoes a very rapid transition similar to that of EPPS. However, there are a few pronounced differences between these two pension schemes. First of all, the number of NTPS beneficiaries (BFNT) declines after the year 2015. This may be attributable principally to industrial and employment structural changes. For the same reason, the number of NTPS pension contributors decreases slightly sooner than those of EPPS. Moreover, as shown in Columns (7) and (8) of Table XIV.15. NTPS start operating under the PAYG principle from the year 2004, which is one year earlier than EPPS. This result seems consistent with the general observations that NTPS has already been operating under the financing principle close to PAYG and that NTPS has a weaker financial foundation than EPPS.

Another public pension programme considered in the present study is the Welfare Pension Programme (WPP) which is the non-contributory component of NTPS. As discussed earlier, WPP is a transitional pension scheme. This basic nature is clearly illustrated by the figures of Table XIV.16. In the next few decades the number of beneficiaries (BFWP), and the amount of benefits to be paid out (PNWP) shrink drastically.

The second major component of the social security submodel cosists of a variety of public medical plans. As with the public pension schemes, we will examine each of the three leading health programmes.

Table XIV.17 contains a set of the principal variables representing the impact of changes in economic and demographic factors upon the Government-managed Health Insurance Plan (GMHIP). PIGM, which denotes the number of members enrolled in GMHIP, continues to increase until the year 2003, after which it starts to decrease gradually. Again, this growth pattern is in close agreement with that of the working-age population. Although the average family size (HS) becomes smaller as simulation proceeds, as a concomitant of the growth of PIGM the number of GMHIP members' dependents (PFGM) continues to grow until 2003. As a result of population aging and sustained growth of GNP, the medical cost per case for the member (MCPDIGM) rises 70.4 times over the simulation period. This enormous increase in the medical cost per case in directly reflected in the rapid growth of the total medical cost for the members (MCIGM). The same observation is applicable to their dependents, as shown by changes in MCPDFGM and MCFGM in Table XIV.17. The total

Table XIV.15. Changes in selected variables of the national pension scheme

Year	(1) BFNT (million persons)	(2) PNNT (trillions of yen)	(3) PCPNNT (millions of yen)	(4) PINT (million persons)	(5) RSINT (thousands of yen)	(6) GSNT (trillions of yen)	(7) RFNT (trillions of yen)	(8) GAPNT (billions of yen)
1980	5.209	1.37	0.263	28.48	3.70	0.59	2.64	296
1985	6.799	2.44	0.359	31.21	5.90	1.07	5.30	689
1990	7.818	4.04	0.516	33.98	8.03	1.87	10.04	1 218
1995	8.269	6.39	0.772	36.26	10.16	3.21	17.26	1 714
2000	8.433	10.35	1.227	37.05	12.29	5.56	25.13	1 440
2005	8.635	17.66	2.045	36.30	34.96	9.86	27.49	0
2010	8.961	31.67	3.534	34.51	70.60	17.96	27.50	0
2015	9.213	53.32	5.787	32.90	128.79	30.46	27.50	0
2020	9.037	71.57	7.920	32.26	180.45	41.46	27.51	0
2025	8.821	88.31	11.011	31.43	232.62	51.78	27.52	0

Table XIV.16. Changes in selected variables of the welfare pension programme

Year	(1) BFWP (thousand persons)	(2) PNWP (billions of yen)	(3) PCPNWP (thousands of yen)
1980	3 245	718.3	221.9
1985	1 871	528.6	282.5
1990	852	307.2	360.6
1995	285	131.2	460.2
2000	64	37.6	587.3
2005	9	6.7	749.6
2010	1	1.0	956.7
2015	0	0	1 221.0
2020	0	0	1 558.4
2025	0	0	1 988.9

medical cost (MCGM), which is the sum of MCPDIGM and MCIGM, grows at an astonishing rate throughout the simulation period.

To keep this medical plan solvent, these rapidly rising medical expenditures need to be matched by increasing contributions by GMHIP members (SIGM) and Government subsidies (GSGM). This point is clearly illustrated by both Columns (11) and (12) of Table XIV.17. The rise in the relative financial burden to be placed upon GMHIP members is expressed by a substantial and continuous increase in the contribution rate (RSIGM). During the simulation period, the contribution rate rises 3.21 times from 8.9 to 28.6 per cent.

Tables XIV.18. and XIV.19. present simulated results of selected variables of the Association-managed Health Insurance Plan (AMHIP) and the National Health Insurance Plan (NHIP), respectively. By comparing these two tables with Table XIV.17.,one can easily conclude that the observations made with regard to GMHIP are, by and large, applicable to both AMHIP and NHIP. It is worth remarking, however, that the number of persons enrolled in NHIP (PINH) changes in a markedly different way, as compared with the two other medical plans. This difference is due to the fact that both AMHIP and GMHIP cover most of those in the labour force and their families, while NHIP includes retirees and their spouses. In the early part of the next century PINH grows swiftly as a result of the relative increase in the number of aged persons.

In the above we have considered changes in selected variables on a programme basis. We will now look into some of macro-level variables of the social security submodel.

Both pension and medical benefits paid out constitute the major portion of transfer payments (TR) of the contemporary Japanese social security system.

Table XIV.17. Changes in selected variables of the government-managed health insurance plan

Year	(1) PIGM (million persons)	(2) PFGM (million persons)	(3) MCPDIGM (thousands of yen)	(4) CRIGM (times)	(5) MCIGM (trillions of yen)	(6) MCPDFGM (thousands of yen)	(7) CRFGM (times)	(8) MCFGM (trillions of yen)	(9) MCGM (trillions of yen)	(10) RSIGM (per cent)	(11) SIGM (trillions of yen)	(12) GSGM (trillions of yen)
1980	14.22	16.32	17.6	6.604	1.65	12.8	6.327	1.32	3.0	8.9	2.4	0.50
1985	15.02	17.23	27.7	6.604	2.74	20.8	6.327	2.26	5.0	10.7	4.0	0.83
1990	15.82	18.16	44.5	6.604	4.65	34.0	6.327	3.91	8.6	12.8	6.9	1.42
1995	16.57	19.01	78.8	6.604	8.62	61.2	6.327	7.36	16.0	16.7	12.8	2.65
2000	17.03	19.53	139.8	6.604	15.72	109.4	6.327	13.52	29.2	21.0	23.4	4.84
2005	17.04	19.55	235.4	6.604	26.50	185.0	6.327	22.89	49.4	23.6	39.4	8.17
2010	16.68	19.14	396.3	6.604	43.65	312.2	6.327	37.80	81.4	24.6	64.9	13.47
2015	16.18	18.60	683.4	6.604	73.04	539.1	6.327	63.34	136.4	27.0	108.7	22.56
2020	15.89	18.23	967.8	6.604	101.55	764.0	6.327	88.12	189.7	28.3	151.1	31.37
2025	15.67	17.98	1 239.9	6.604	128.83	979.1	6.327	111.37	239.7	28.6	191.0	39.65

Table XIV.18. Changes in selected variables of the association-managed health insurance plan

Year	(1) PIAM (million persons)	(2) PFAM (million persons)	(3) MCPDIAM (thousands of yen)	(4) CRIAM (times)	(5) MCIAM (trillions of yen)	(6) MCPDFAM (thousands of yen)	(7) CRFAM (times)	(8) MCFAM (trillions of yen)	(9) MCAM (trillions of yen)	(10) RSIAM (per cent)	(11) SIAM (trillions of yen)	(12) GSAM (trillions of yen)
1980	12.02	17.01	15.1	5.428	0.99	11.3	6.441	1.24	2.2	8.0	2.2	6.0
1985	13.56	19.18	23.9	5.428	1.76	18.1	6.441	2.24	4.0	9.5	3.9	10.8
1990	15.10	21.37	38.6	5.428	3.16	29.5	6.441	4.06	7.1	11.3	7.0	19.5
1995	16.53	23.39	68.6	5.428	6.15	52.7	6.441	7.94	13.7	14.8	13.6	38.0
2000	17.41	24.63	121.8	6.428	11.52	94.0	6.441	14.91	25.7	18.6	25.5	71.2
2005	17.44	24.68	205.4	5.428	19.44	158.7	6.441	25.22	43.3	20.8	43.1	120.3
2010	16.74	23.69	345.9	6.428	31.44	267.5	6.441	40.81	69.9	21.7	69.8	194.6
2015	15.80	22.35	596.6	5.428	51.15	461.6	6.441	66.45	113.7	23.7	113.6	316.8
2020	15.23	21.54	845.0	5.428	69.84	654.0	6.441	90.75	155.2	24.9	155.1	432.6
2025	14.81	20.95	1 082.6	5.428	87.01	838.1	6.441	113.07	193.4	25.2	193.2	539.0

Table XIV.19. Changes in selected variables of the national health insurance plan

Year	(1) PINH (million persons)	(2) HINH (million persons)	(3) CRINH (times)	(4) MCPDINH (thousands of yen)	(5) MCINH (trillions of yen)	(6) RSINH (millions of yen)	(7) SINH (trillions of yen)	(8) GSNH (trillions of yen)
1980	43.75	15.05	6.203	15.9	4.3	0.08	1.13	2.1
1985	42.02	14.45	6.203	25.7	6.7	0.11	1.80	3.3
1990	39.57	13.61	6.203	42.0	10.3	0.21	2.81	5.1
1995	37.49	12.89	6.203	75.5	17.6	0.38	4.88	8.6
2000	37.17	12.78	6.203	134.9	31.1	0.69	8.77	15.2
2005	38.68	13.31	6.203	228.0	54.7	1.17	15.61	26.8
2010	41.04	14.11	6.203	384.6	97.9	2.00	28.17	48.0
2015	42.87	14.75	6.203	664.1	176.6	3.47	51.11	86.6
2020	42.69	14.68	6.203	941.0	249.2	4.92	72.21	122.2
2025	41.76	14.36	6.203	1 205.9	312.4	6.30	90.52	153.2

At the present time, the benefits paid out under the public medical plans exceed those under pension schemes by a considerable marin. Due to the growing maturity of public pension schemes and an increasing proportion of the aged population, the latter surpasses the former until 1986, and this difference grows increasingly larger as years proceed. In the early part of the next century, pension benefit payments become the majority of the total benefit payments of the social security system. Figure XIV.15. depicts this changing pattern in the relative share of benefits of public medical plans and pension schemes in terms of the total benefit payments under the social security system. TRPN denotes the total benefits paid out under the public pension schemes, TRME, under the medical plans, and TROTH, under various other social security programmes.

We now analyse briefly the pattern of changes in the six macro-level variables to be incorporated into the economic submodel from the social security submodel. Table XIV.20. sets out the simulated values of these six variables. SMTR, which is the total sum of medical benefits paid out through all the public medical insurance plans, increases at an enormous rate, as shown in Column (1). The similar growth pattern is true of total medical expenditure (SMX). In 1980 the size of SMX is only 4.53 per cent of GNPN. In 2025, however, it rises to 16.45 per cent. The total benefits paid through the social security system (TR) and the total contributions to the social security system (SI) grow 82.63 times and 89.29 times over the period of 1980-2025, respectively. Employers' contributions to the social security system (SIE) and the amount of cash benefits paid through the social security system (GNKTR) also grow in magnitude at comparable levels to those of both TR and SI.

To facilitate an international comparison on the financial magnitude of the social security benefits the ratio of TR to national income (NI) is often employed. The other common indicator used for international comparative purposes is the ratio of the social security contributions (SI) to NI which measures the financial burden of the social security programmes placed upon the national economy. The growth patterns of both TR/NI and SI/NI are shown in the Figure XIV.16. Throughout the simulation period, they expand monotonically and almost in parallel to each other. The value of TR/NI is 12.46 per cent in 1980, and in 2025 it achieves a level of 48.70 per cent. SI/NI takes a value of 9.46 per cent in 1980, and of 39.94 per cent in 2025.

One may compare these values with those in the Federal Republic of Germany and Sweden. According to the statistics published by the International Labour Office in 1979 [43], the Federal Republic of Germany experienced the growth of TR/NI from 15.8 to 25.2 per cent over the period of 1960-1977. During the corresponding period, Sweden saw the increase of TR/NI from 11.9 to 22.6 per cent. The simulated results of the Standard Case imply that Japan would undergo,

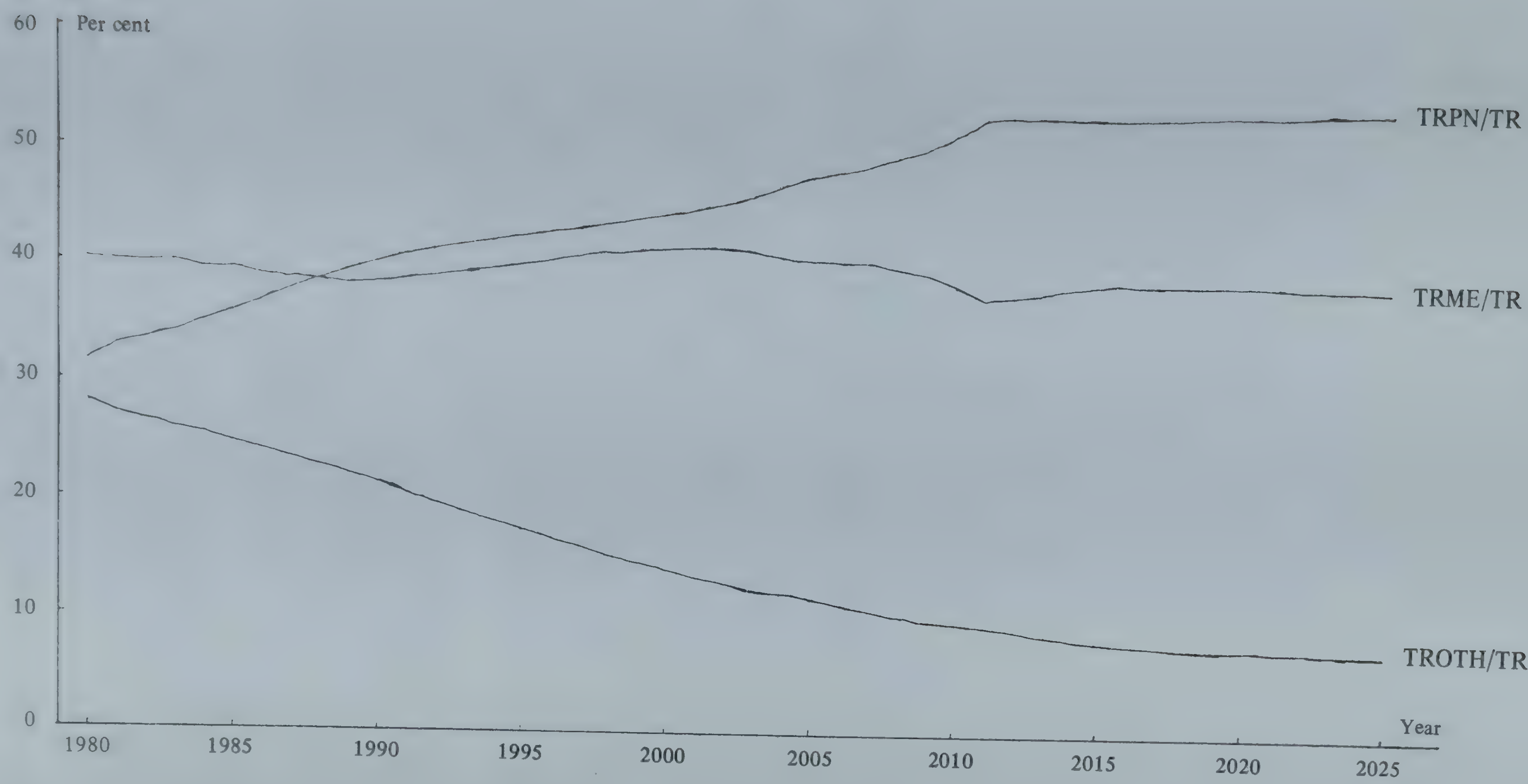


Figure XIV.15. Changes in the relative share of total benefit payments under the social security system

Table XIV.20. Simulated values of social security-related factors

(unit: trillions of yen for (1) – (6); per cent for (7))

Year	(1) SMTR	(2) SMX	(3) TR	(4) SI	(5) SIE	(6) GNKTR	(7) (TAX+SI)/NI
1980	9.1	10.7	23.8	18.1	9.3	12.2	31.36
1985	15.0	17.7	40.3	31.1	16.0	21.4	33.93
1990	25.0	29.3	68.8	53.3	27.6	37.8	36.44
1995	45.8	53.5	121.3	93.9	48.9	66.2	39.49
2000	83.4	97.4	214.0	163.4	85.7	116.2	42.46
2005	178.2	142.8	373.3	274.1	143.8	208.4	46.13
2010	240.7	282.4	660.5	512.5	269.0	385.6	51.60
2015	410.6	483.2	1 122.7	899.6	471.4	659.8	57.82
2020	571.0	672.7	1 558.4	1 267.4	665.0	917.7	61.54
2025	716.5	844.1	1 970.1	1 615.7	849.4	1 167.3	63.31

only in 12 years (from 1989 to 2001), the same transformation as the Federal Republic of Germany achieved in 15 years, and that Japan would go through the same process, in 29 years (from 1979 to 2008), as Sweden actually did in 15 years. From these observations Japan's public expenditures for the social security might be required to increase at a rate faster than that of the Federal Republic of Germany and slower than that for Sweden. Note, however, that beyond the year 2009 Japan's simulated value of TR/NI becomes increasingly large than that of contemporary Sweden. Given this long-run perspective, the Government of Japan might as well formulate comprehensive policies to cope with a vast rise in social security-related expenditures in the next several decades.

Furthermore, the total financial burden to be placed upon taxpayers can be measured as the ratio of total taxes and social security contributions to national income, (TAX + SI)/NI. As presented in Column (7) of Table XIV.20, largely due to the fast growth of required social security contributions the financial strain imposed upon general taxpayers increases from 31.36 in 1980, to 42.46 in 2000, and to 63.31 per cent in 2025. These computed results indicate that the relative financial burden upon the future population is likely to accelerate in the first two decades of the next century.

C. ALTERNATIVE FERTILITY CASE

In the Standard Case, changes in TFR were subject to variations in both economic and nuptiality factors, although the floor value has been incorporated in the total fertility equation. As alternatives to this fertility path, the following two opposing fertility cases are considered:

High Fertility Case – The level of TFR in the Tth year corresponds to the sum of the TFR of the Standard Case in that year and the incremental term expressed as follows:

$$-0.069897 + 0.0217147 \ln (T + 5)^2 \text{; and}$$

Low Fertility Case – The level of TFR in the Tth year is computed as the difference between the TFR of the Standard Case in that year and the following term:

$$-0.1398 + 0.043429 \ln (T + 5)^2.$$

Note that at the end of the simulation period the incremental term for the High Fertility Case becomes equal to 0.1 while the subtraction term for the Low Fertility Case, equal to 0.2.

Figure VI-17 shows simulated changes in TFR for these three different fertility cases. In the High Fertility Case a level of TFR fluctuates around the value of 1.8, and takes the value of 1.803 in 2025. In the Low Fertility Case TFR falls almost continously down to a level of 1.505 in the terminal year of simulation. It should be stressed that these alternative fertility paths to the Standard Case are not exactly the same but are largely comparable to the high variant and the low variant of the NU population projection.

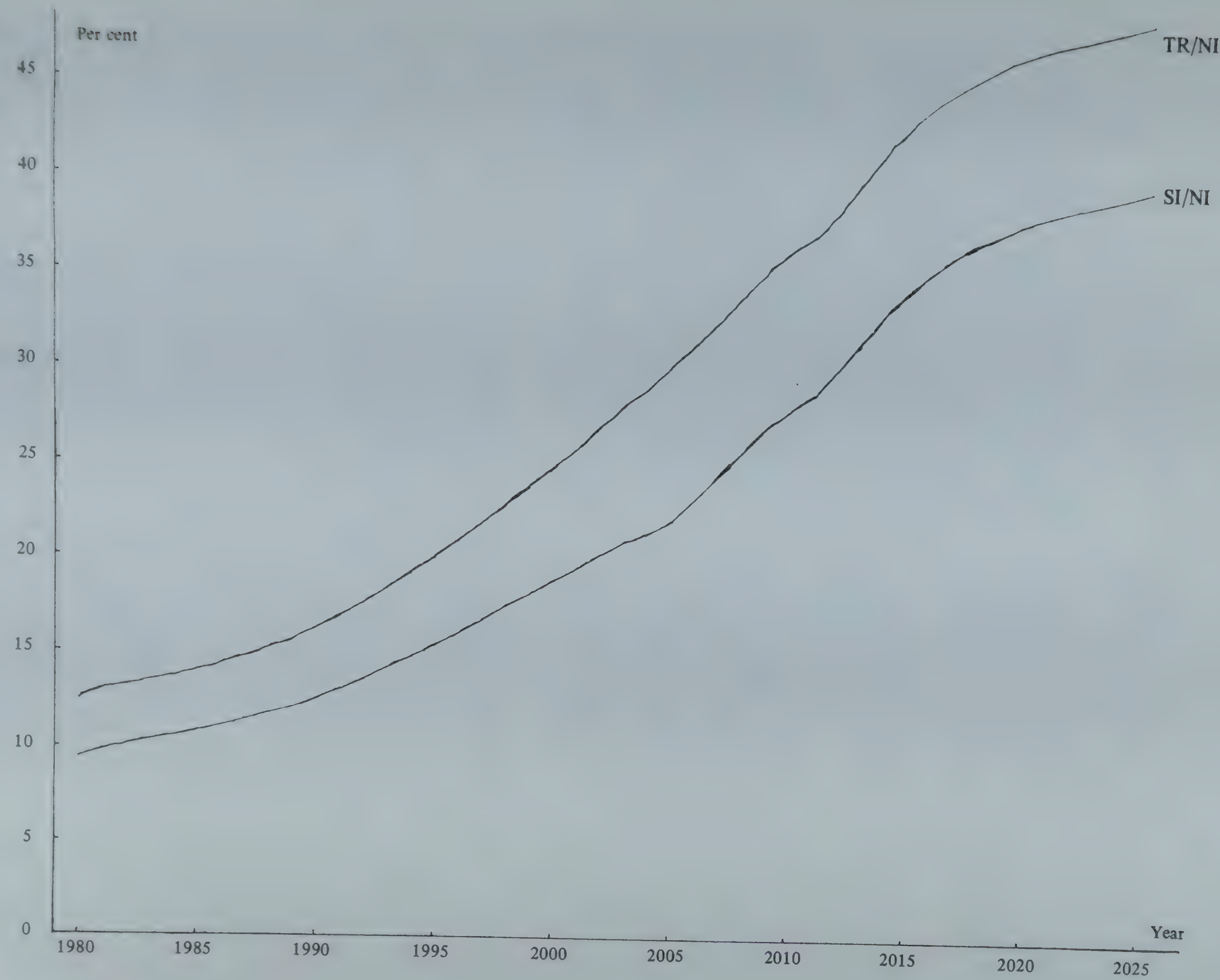


Figure XIV.16. Changes in transfer payments and contributions under the social security system

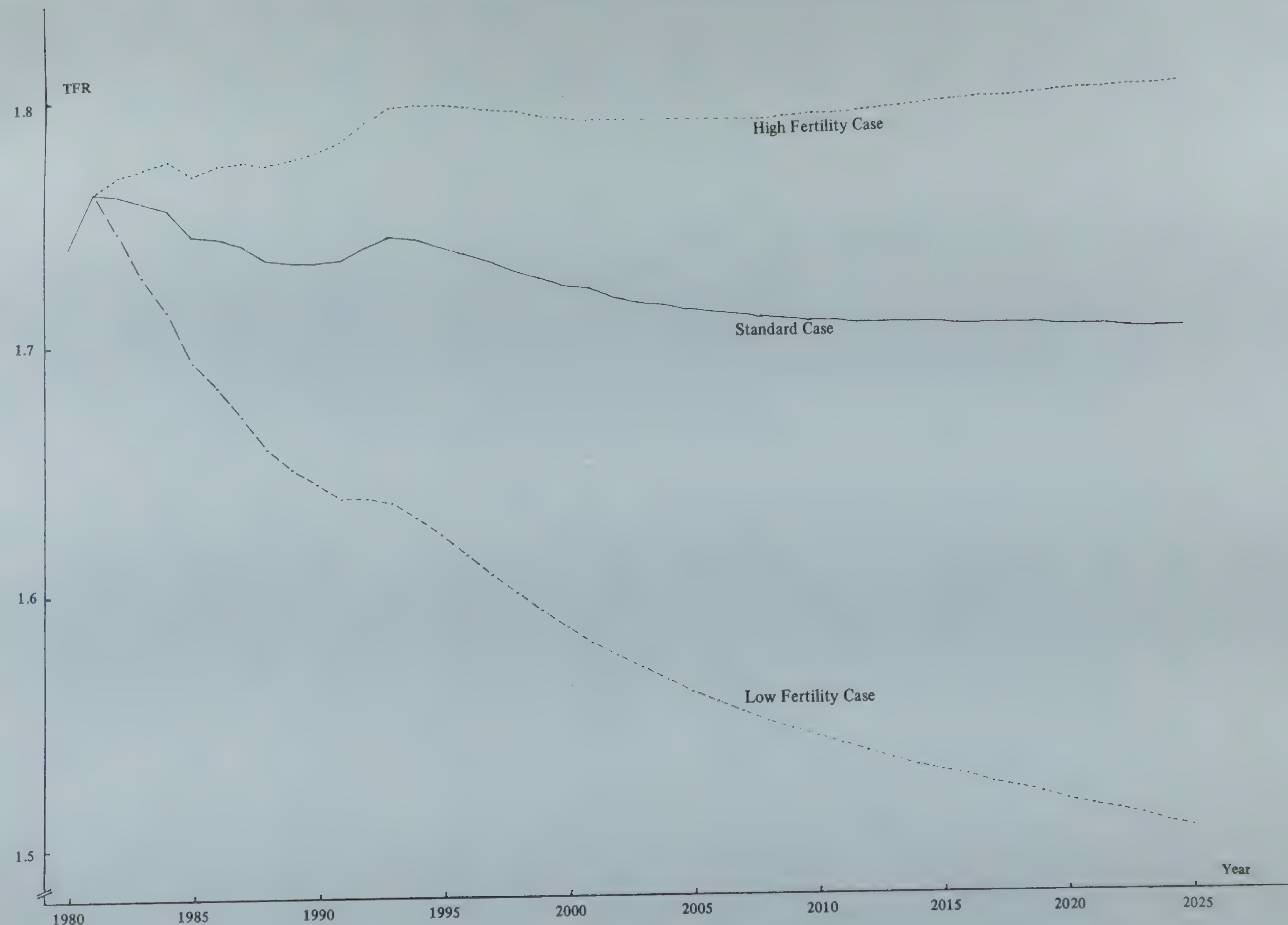


Figure XIV.17. Changes in TFR in three cases

These different fertility paths affect women's age at first marriage through the marriage squeeze effect. The impact of these fertility levels upon nuptiality becomes discernible only after 1995, as depicted in Figure XIV.18. The higher the fertility level is, the larger the size of young cohorts, thus lowering women's probability of early marriage and consequently, age at first marriage.

Among these three fertility paths, the High Fertility Case has the largest population size throughout the simulation period, while the Low Fertility Case, the smallest one. As indicated in Figure XIV.19., the High Fertility Case reaches its peak value of 132.50 million persons in 2008, and the Low Fertility Case, 129.00 million persons in 2005. (Note that the Standard Case has its maximum population size of 131.27 million persons in 2007, as has been previously discussed.)

These three alternative population growth paths yield different values of the following three vital rates: the crude birth rate (CBR), the crude death rate (CDR) and the rate of natural increase (RNI). Table XIV.21. presents these vital rates for both High and Low Fertility Cases. Although both RNIs and CBRs are constantly higher in the High Fertility Case than in the low Fertility Case, changes in CDRs show the opposite pattern.

As regards age structural transformations, the Low Fertility Case constantly produces a higher proportion of the aged population to the total population, as compared with either the Standard Case or the High Fertility Case. As shown in Figure XIV.20., the percentage of the aged population for the Standard Case continues to increase up to the year 2021, after which it diminishes gradually. The High Fertility Case shows a similar pattern over time. The peak value for the former case is 23.88 per cent in 2021, and 23.45 per cent in the same year for the latter. In contrast, the Low Fertility Case shows a constantly growing percentage of the aged population throughout the simulation period, thus reaching its maximum value of 24.88 per cent in 2025. These results lead to the conclusion that lower fertility contributes to faster population aging.

Figure XIV.21. illustrates changes in the index of aging for the three fertility cases. Here again, one can clearly observe that lower fertility induces more rapid population aging.

We now examine the effect of these alternative fertility growth patterns upon some of the crucial economic indicators. Table XIV.21. presents simulated changed in three economic variables for the two alternative fertility cases. In terms of nominal GNP, these two alternative cases show no pronounced difference in the first two decades. At the turn of the century, the Low Fertility Case starts to yield a considerably larger GNPN than the High Fertility Case, and the

Table XIV.21. Selected vital rates for high and low fertility case

(unit: per 1,000 persons)

Year	High Fertility Case			Low Fertility Case		
	CBR	CDR	RNI	CBR	CDR	RNI
1980	13.34	6.16	7.18	13.34	6.31	7.03
1985	11.84	6.42	5.43	11.26	6.42	4.84
1990	11.76	6.81	4.95	10.88	6.84	4.04
1995	12.64	7.57	5.07	11.49	7.64	3.85
2000	12.52	8.56	3.96	11.25	8.70	2.55
2005	11.08	9.70	1.38	9.83	9.92	–0.09
2010	9.93	10.96	–1.03	8.54	11.30	–2.75
2015	9.71	12.12	–2.42	8.06	12.62	–4.57
2020	10.31	13.10	–2.80	8.33	13.80	–5.46
2025	10.84	13.92	–3.07	8.63	14.86	–6.23

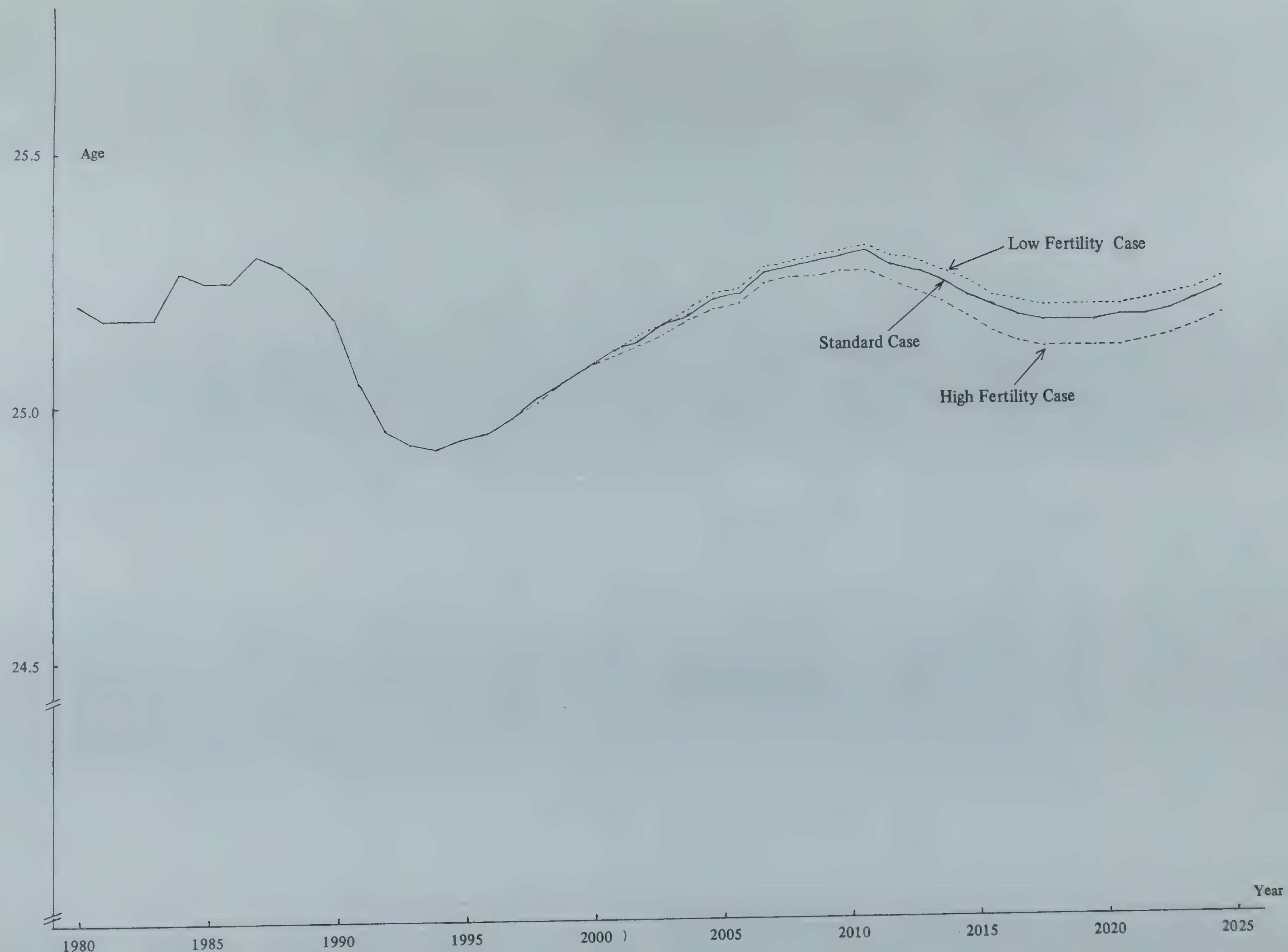


Figure XIV.18. Women's age at first marriage in three fertility cases

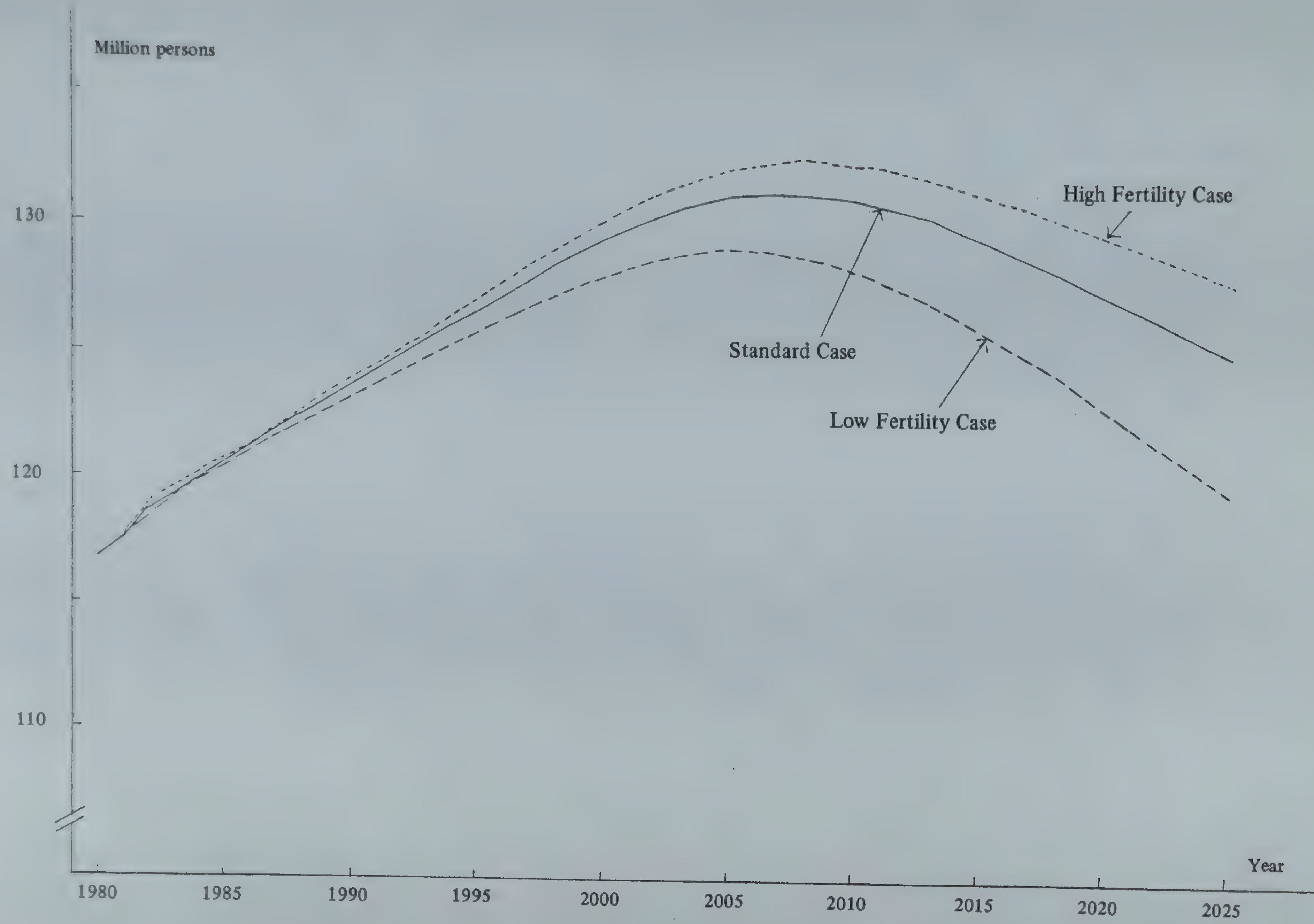


Figure XIV.19. Simulated pattern of population growth in three cases

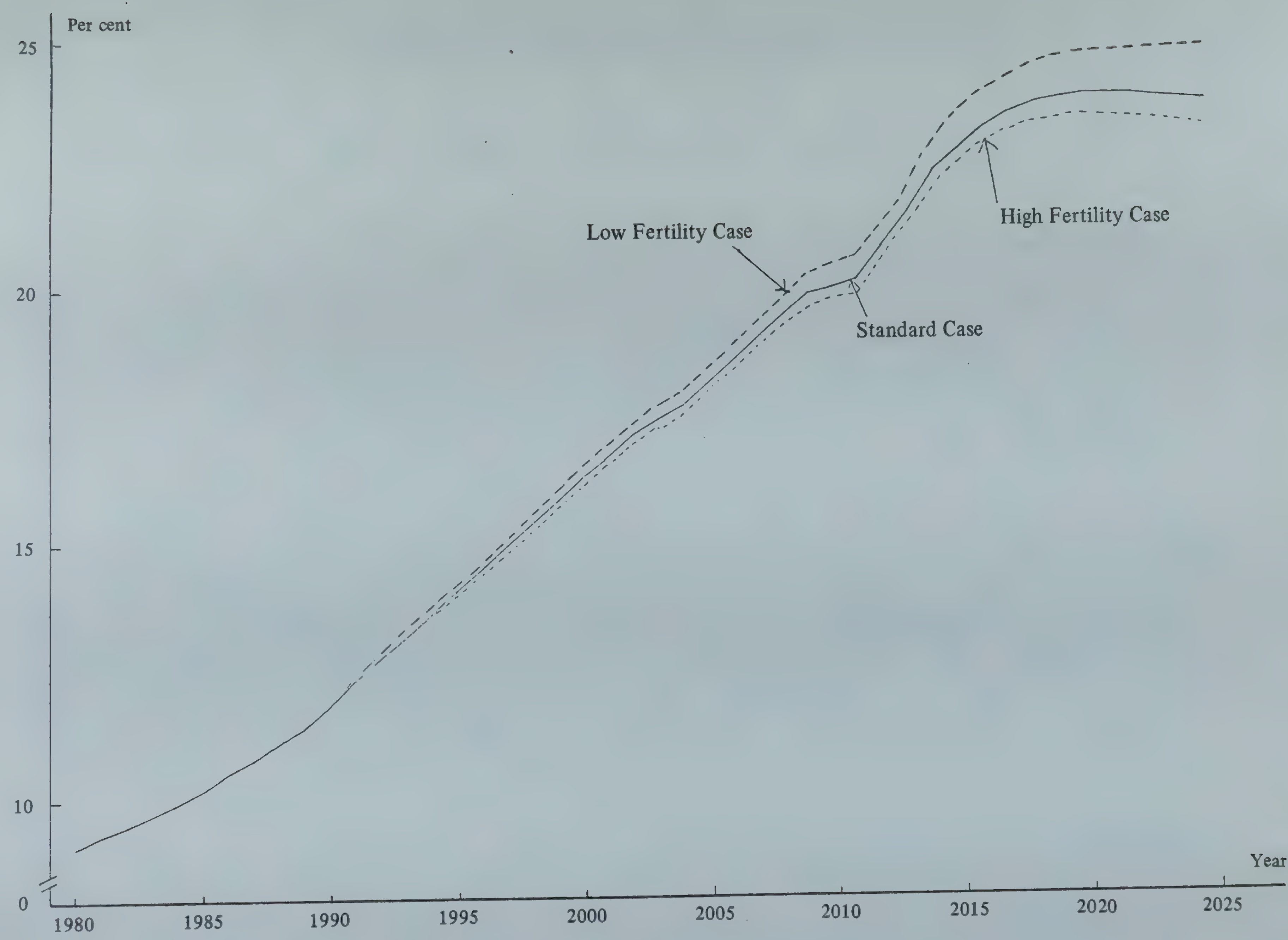


Figure XIV.20. Changes in the percentage of those aged 65 and over in three cases

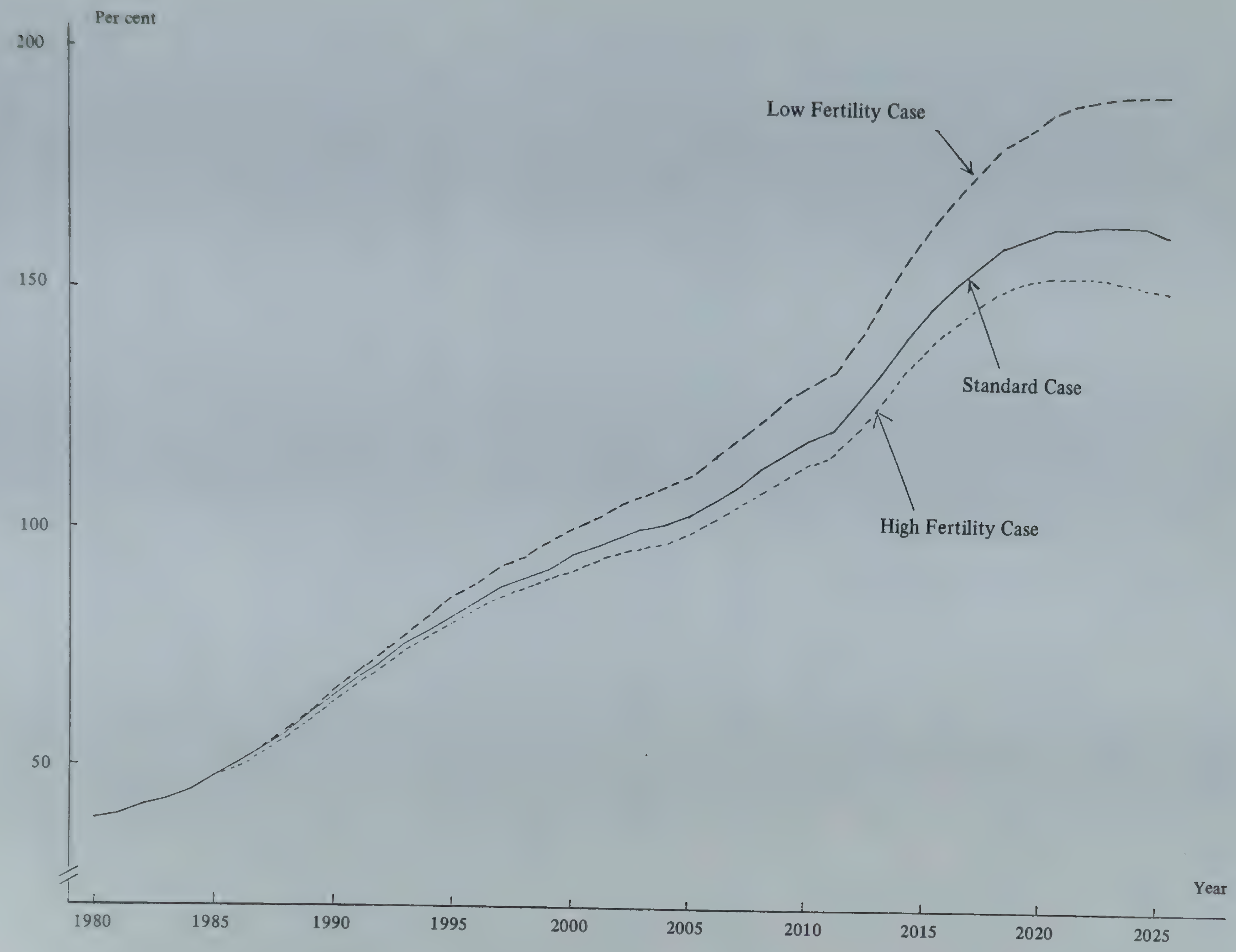


Figure XIV.21. Simulated values of the index of aging for three population growth cases

Table XIV.22. Simulated changes in selected economic variables for two opposing fertility cases

Year	High Fertility Case			Low Fertility Case		
	GNPN (trillions of yen)	GNPR (trillions of yen)	GNPR/POP (millions of yen)	GNPN (trillions of yen)	GNPR (trillions of yen)	GNPR/POP (millions of yen)
1980	237.2	193.7	1.655	237.2	193.7	1.655
1985	325.8	255.0	2.111	352.9	255.0	2.114
1990	521.1	325.0	2.622	521.3	325.0	2.636
1995	751.5	399.5	3.142	752.0	399.5	3.176
2000	1 074.8	473.3	3.635	1 077.8	473.5	3.699
2005	1 539.4	542.5	4.105	1 554.4	542.4	4.205
2010	2 262.9	603.0	4.554	2 315.1	601.9	4.694
2015	3 221.0	656.5	5.001	3 358.7	652.7	5.182
2020	4 102.0	707.0	5.457	4 388.4	697.8	5.680
2025	4 974.0	760.9	5.957	5 467.0	743.5	6.227

relative difference expands for the rest of the simulation period.

One can however, observe a totally different picture with respect to changes in real GNP. GNPR for the Low Fertility Case is slightly larger than that for the High Fertility Case up to 2004. In the last two decades of simulation, however, the Low Fertility Case produces a level of GNPR lower than the High Fertility Case. The rationale behind the reversal in the size of GNPR between the two fertility cases is that although in the early years of simulation the capital-deepening effect of lower fertility dominated the negative effect of fertility reduction upon the labour force, the latter effect exceeds the former effect in later years. Furthermore, this difference in the growth pattern of GNPN and GNPR between these two alternative fertility cases indicates that the Low Fertility Case is likely to undergo a faster rate of inflation than the High Fertility Case; the source of this faster inflation for the former is higher labour costs (caused by its smaller labour force).

On the basis of *per capita* GNPR, however, the Low Fertility Case produces a higher value than the High Fertility Case throughout the simulation period. The mechanism behind this result is that although GNPR for the Low Fertility Case is exceeded by GNPR for the High Fertility Case in the second half of the simulation period, the total population for the Low Fertility Case shrinks at a rate faster than that for the High Fertility Case.

With regard to the growth rate of GNPR, we have plotted simulated patterns for three fertility cases in Figure XIV.22. In the first two decades or so, the Low Fertility Case undergoes a slightly faster GNPR growth rate than the High Fertility Case does. Because this difference is marginal, it can not be visualized in Figure XIV.22. Towards the end of the simulation period, however, the growth rate of GNPR is higher for the High Fertility Case than for the low Fertility Case, as clearly indicated in Figure XIV.22.

D. ALTERNATIVE MORTALITY CASE

In Section B of this chapter, we noted that there is a considerable difference in the pattern of mortality changes among the three population growth paths. The difference is the most pronounced between the Standard Case and the 1981 MHW population projection. To quantify this difference, we have substituted the survival pattern of the MHW projection assumed to be achieved in 2025 for the life table synthesized by Hishinuma. The replacement of the targeted mortality condition has produced a few interesting findings.

Table XIV.23. presents some of the simulated results. As indicated in Columns (1) and (2), life expectancy at birth improves very quickly for both males and females. Males life expectancy at birth a symptotically approaches 75.07 years by the year 1996. Female life expectancy at birth almost reaches the targeted level

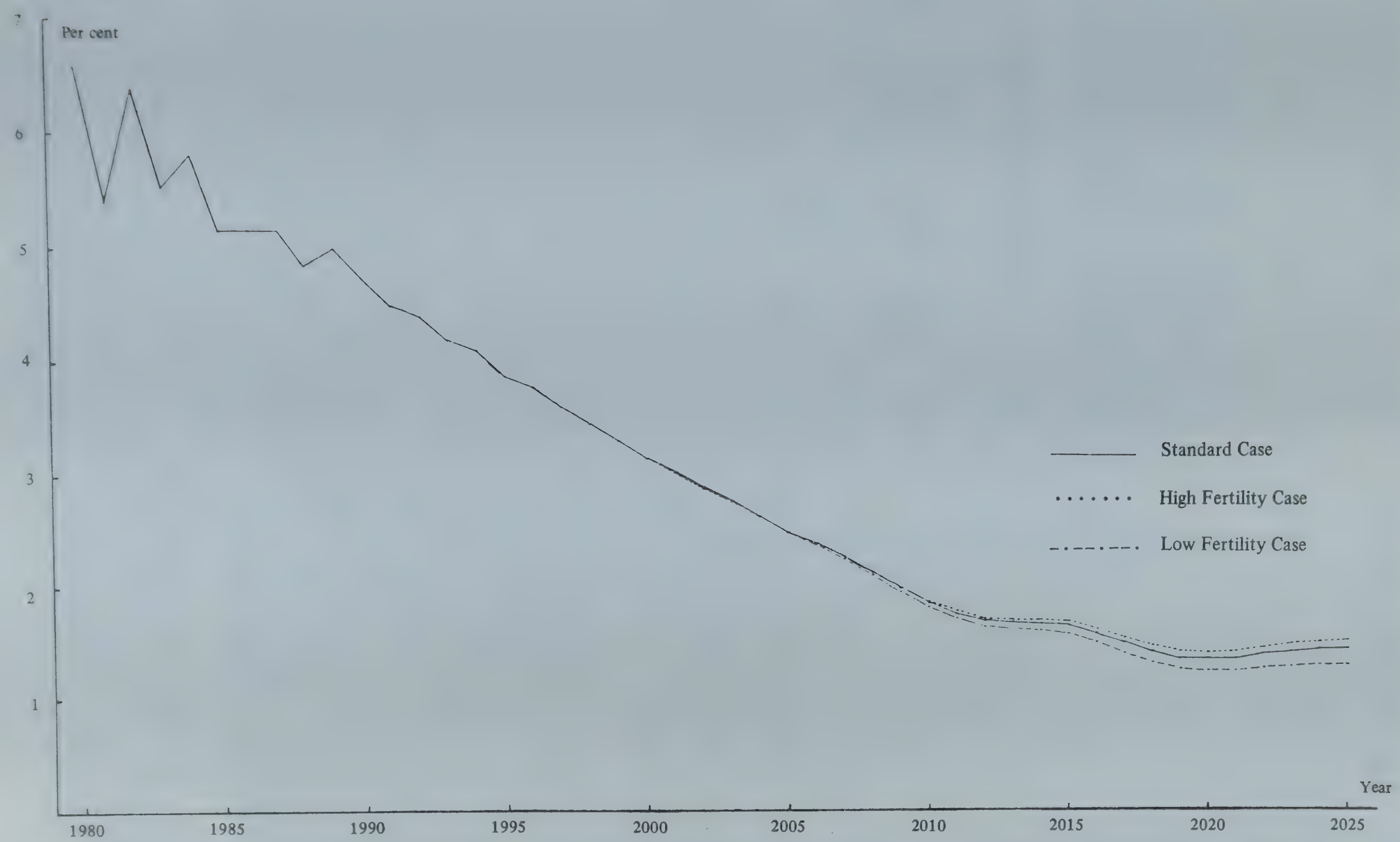


Figure XIV.22. Simulated patterns of real GNP growth rates for three alternative fertility cases

Table XIV.23. **Simulated population growth patterns with the alternative mortality assumption**

Year	Male life expectancy at birth (years)	Female life expectancy at birth (years)	Total population (thousand persons)
1980	73.23	78.53	117 060
1985	74.33	79.66	120 634
1990	74.90	80.24	123 331
1995	75.06	80.40	125 806
2000	75.07	80.41	128 069
2005	75.07	80.41	129 210
2010	75.07	80.41	128 701
2015	75.07	80.41	126 858
2020	75.07	80.41	124 373
2025	75.07	80.41	121 735

of 80.41 years in the same year. Insofar as the total population size is concerned, this Alternative Mortality Case predicts a growing population up to the year 2006, after which the total population size starts declining at a gradual pace. The peak value of the population size is 129.24 million persons, which is 1.55 per cent smaller than that of the Standard Case.

Naturally, the Alternative Mortality Case yields a different pattern of population aging, as compared with the Standard Case. As depicted in Figure XIV.23 the Alternative Mortality Case which is equipped with lower survival rates shows a slower growth of the percentage of the population aged 65 and over than the Standard Case. The peak value, which is 22.57 per cent over the period 2020-2021, is 1.31 per cent points lower than that for the Standard Case. In terms of the absolute size of the aged population, the Alternative Mortality Case has its maximum of 28.144 million persons in 2018, while the Standard Case, 30.372 million persons in 2020. Furthermore, one can make similar observations for both population growth cases with regard to other aging-related indices. (Tables not shown.)

Nevertheless, these relative and absolute differences in population size and its growth pattern between the two cases have only marginal effects upon economic and social security variables, as listed in Table XIV.24. As compared with the Standard Case, the Alternative Mortality Case produces a slightly higher level of nominal GNP throughout the simulation period except the first few years. In 2025 the GNPN of the Alternative Mortality Case is about 2.9 per cent larger than that of the Standard Case. On the basis of real terms, the Standard Case yields higher GNPR than the Alternative Mortality Case up to the year 2002. During this time period, the relative difference between these two cases increases up to the year 1995, after which it starts to diminish. In 2025, the Alternative Mortality Case has a GNPR 2.95 per cent larger than that for the Standard Case. These changes in the level of GNPR are directly reflected by the variation of its annual growth rate, as described in Column (3) of Table XIV.24.

Table XIV.24. **The effect of alternative mortality conditions upon selected economic variables**

Year	GNPN (trillions of yen)	GNPR (trillions of yen)	Annual growth rate of GNPR (per cent)	GNPR/POP (millions of yen)
1980	237.2	193.7	6.58	1.655
1985	352.9	254.9	5.13	2.113
1990	522.4	324.7	4.72	2.632
1995	757.4	398.8	3.87	3.170
2000	1 092.2	473.0	3.17	3.693
2005	1 590.9	543.5	2.56	4.206
2010	2 381.9	606.1	1.96	4.710
2015	3 464.4	663.0	1.78	5.226
2020	4 536.2	718.0	1.54	5.773
2025	5 675.2	777.5	1.63	6.386

The growth of *per capita* GNPR, however, shows a substantially different picture. As presented in Column (4) of the same table, the Alternative Mortality Case constantly has a higher level of *per capita* GNPR than the Standard Case. More importantly, the relative difference in *per capita* GNPR grows over time; in 1985 the *per capita* GNPR of the Alternative Mortality Case is only 0.05 per cent larger than that of the Standard Case, and in 2025 it becomes 5.62 per cent.

The labour force size proves to be one of the main sources of these differences in the growth patterns of the economic variables. Because of its lower survival rates for all age groups, the Alternative Mortality Case has a smaller labour force throughout the simulation period. For instance, in 2000 the labour force size of the

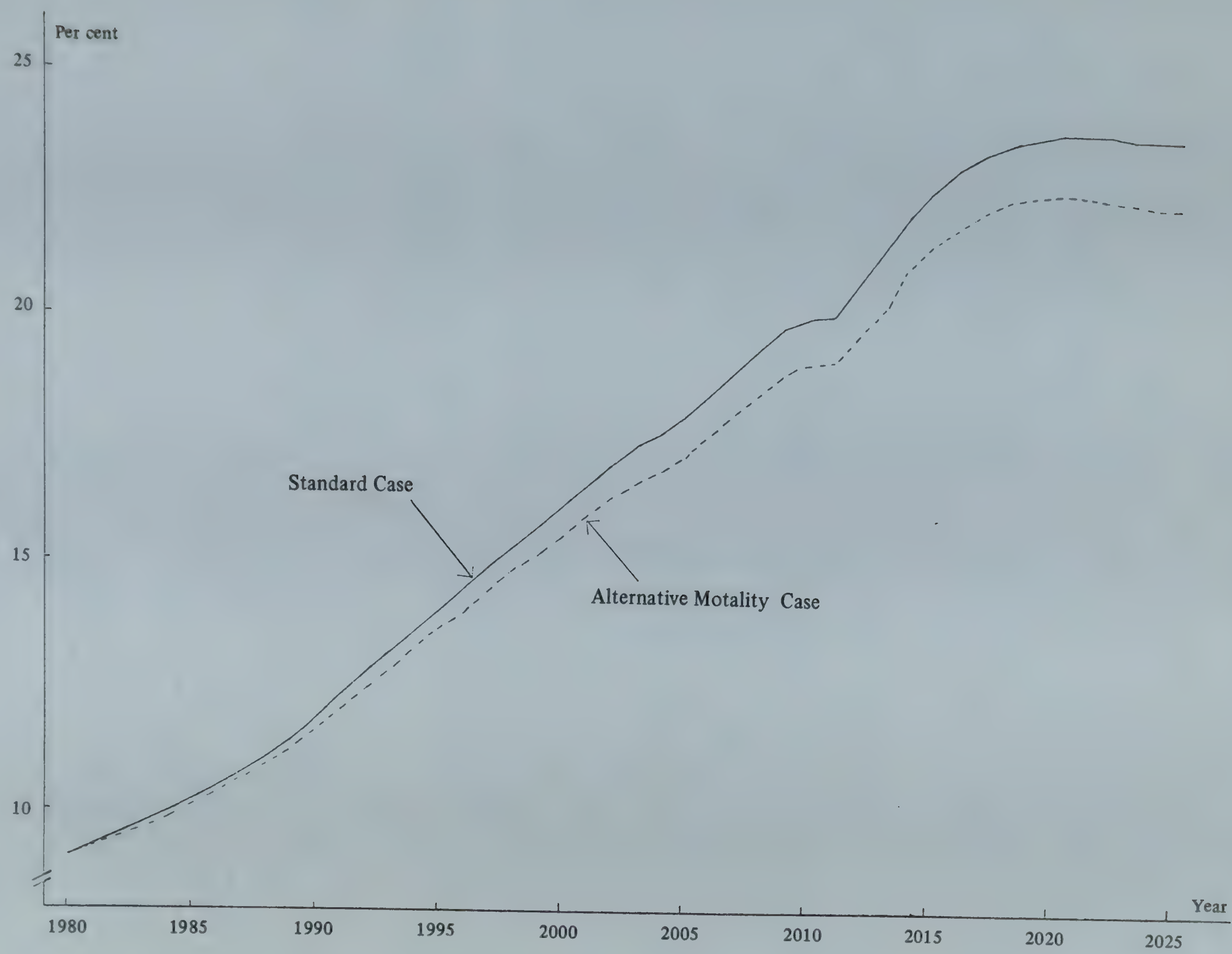


Figure XIV.23. Simulated pattern of changes in the percentage of population aged 65 and over for two opposing cases

Alternative Mortality Case is 1.07 per cent smaller than that of the Standard Case, and in 2025 it amounts to 2.12 per cent. (Tables not shown).

Another source of the differences is related to social security payments. The impact of the difference in morality rates upon macro-level social security variables becomes considerable in the early part of the next century. Specifically speaking, the proportion of national income to be allocated for the payment of social security benefits is 24.17 per cent for the Alternative Mortality Case and 24.74 per cent for the Standard Case in the year of 2000 this difference increases to 2.29 per cent points in the year 2025.

At more micro-oriented levels, one can also note a number of considerable impacts. For example, in the Alternative Mortality Case both public pension schemes call for higher contribution rates. In the case of EPPS the contribution rate in 2025 is 41.78 per cent rather than 40.20 per cent. (which is required under the Standard Case) In NTPS the annual contribution for 2025 amounts to 281,724 yen which is 21.2 per cent larger than the Standard Case. As for the medical plans, the Alternative Mortality Case calls for lower contribution rates. The most pronounced difference can be observed with respect to GMHIP; in 2025 the Alternative Mortality Case requires 22.97 per cent rather than 28.58 per cent. These results have been derived from the following mechanism: the difference in mortality conditions induces different age structural changes, which, in turn, favourably or unfavourably affects patterns of costs and benefits of intergenerational transfers (public pension schemes) and intragenerational transfers (medical plans).

E. LOW WELFARE CASE

To quantify the effect of an alternative welfare benefit level upon the overall system, we have undertaken a simulation of the Low Welfare Case under the following several assumptions on public pension schemes. Note that the medical plan component remains unchanged. First, the relative size of benefits in terms of the employees' average wage (WAGE) is assumed to increase at a rate slower than that for the Standard Case. In 2025, the relative size of the benefit (RPNEP) for EPPS becomes 40.0 per cent rather than 46.29 per cent. (Refer to Figure XIV.3.) In the same year, the relative size (RPNNT) of the benefit for NTPS reaches a level of 10.0 per cent rather than 15.17 per cent. It is assumed that the benefit of each pension linearly improves from the 1980 level to the respective targeted level.

Secondly, lower contribution rates are assumed for both EPPS and NTPS. In the Standard Case, the contribution rate for EPPS (RSIEP) annually increases by 0.4 per cent after 1985 and by an amount of 5,112 yen for NTPS. In contrast, the Low Welfare Case assumes that RSIEP rises by 0.2 per cent and RSINT, by the year 2100. These assumptions are in perfect agreement with the computational framework recommended by the Government's Pension Advisory Committee [22].

Thirdly, the number of beneficiaries (BFEP) for old-age pension under EPPS is assumed to be less than that for the Standard Case. In 2025 BFEP for the Standard Case is 11.757 million persons, and 10.656 million persons for BFEP for the Low Welfare Case. This assumption is based upon the postponement of pensionable age which is included in the recommendations made by the Government's Pension Advisory Committee. According to the recommendation, the pensionable age is raised by one year for every three years between June 1998 and June 2010, and remains unchanged thereafter. The ultimate pensionable age, therefore, becomes 65 years old.

Given these computational assumptions, the Low Welfare Case has been simulated. Table XIV.25. shows the effect of lower benefits upon the financial burden of the social security system. TR/NI, which is listed in Column (1), grows from 12.46 per cent in 1980 to 44.55 per cent in 2025. As shown in Figure XIV.16., the Standard Case has a considerably higher percentage. For

Table XIV.25. Changes in the ratio of social security transfer payments to national income and in the ratio of social security contribution to national income

Year	TR/NI (per cent)	SI/NI (per cent)
1980	12.46	9.46
1985	14.13	10.53
1990	16.16	11.91
1995	19.25	14.36
2000	23.42	17.34
2005	27.90	20.48
2010	33.15	25.55
2015	39.56	31.46
2020	43.08	34.77
2025	44.55	36.23

instance, it increases to a level of 48.70 per cent in 2025. In terms of SI/NI, the Low Welfare Case calls for a level of 36.23 per cent in 2025, which is 3.71 per cent points lower than the Standard Case.

A lower financial burden in the social security system affects the economic submodel, particularly through personal consumption. The equation for the personal consumption of ordinary goods and services (C1R) contains one term capturing the effect of changes in cash transfer payments and another term on changes in disposable income (YDD). Through these terms of the equation, a lower social security financial burden leads to a lower level of personal consumption, employers' social security contributions and government social security outlays all of which in turn, contribute to a greater amount of loanable funds and consequently to a faster growth of productive capacity. This mechanism is clearly reflected by the pattern of changes in the economic variables included in Table XIV.26. Compared with the Standard Case, C1R for the Low Welfare Case is approximately 0.2 per cent smaller in year 2000. Note, however, that the Low Welfare Case yields C1R 3.0 per cent larger than the Standard Case in the year of 2025. The major source of this cross-over phenomenon is the change in GNP. As shown in Columns (2), (3) and (4), GNP in both nominal and real terms is considerably larger, as compared with that for the Standard Case. More importantly, GNPR for the Low Welfare Case is only 0.67 per cent larger in 2000, but in 2025 it is 4.47 per cent greater. The same is true of changes in *per capita* GNPR, and saving rates as indicated in Column (4) and (5), respectively. The growth rate of GNPR for the Low Welfare Case is shown in Figure XIV.24., in comparison with that for the Standard Case.

Another economic variable likely to be affected by the Alternative Welfare Case is male labour force participation for ages 60 and over ($LFPR^{m3}$) which is subject to changes in *per capita* pension benefits. As presented in Table XIV.27., the Low Welfare Case shows a higher level of $LFPR^{m3}$ than the Standard Case throughout the simulation period. Note that although these is hardly any difference over the period 1980-2020, it becomes considerable in the next century.

F. FASTER CAPITAL REPLACEMENT CASE

In the Standard Case, it was assumed that the capital replacement rate (θ) would linearly decline from 5.338 per cent in 1980 to 3.125 per cent in 2025. As an alternative to this assumption we have considered a simulation case in which the value of θ for year 2025 is 4.0 per cent. As mentioned earlier, a level of 4 per cent roughly corresponds to the average value of θ for the United States over the period of 1966-1977.

Table XIV.28. contains the pattern of changes for a few selected economic variables under the assumption of faster capital replacement. Higher capital replacement rates contribute to a slower growth of capital stock, as shown in Column (5). (Refer to Table XIV.8. for comparison.) Up to the year 2000, the difference in

Table XIV.26. Simulated changes in selected macro-economic variables in the low welfare case

Year	C1R (trillions of yen)	GNPN (trillions of yen)	GNPR (trillions of yen)	GNPR/TP (millions of yen)	S/GNPN (per cent)
1980	94.0	237.2	193.7	1.655	37.37
1985	123.2	350.6	255.0	2.112	37.37
1990	153.4	515.8	325.4	2.630	38.10
1995	182.7	742.9	400.9	3.165	39.23
2000	212.2	1 063.8	476.5	3.681	38.86
2005	240.0	1 538.6	548.5	4 183	38.38
2010	260.7	2 273.9	613.9	4.686	38.31
2015	273.5	3 294.3	673.4	5.200	37.39
2020	285.7	4 301.2	729.7	5.732	38.10
2025	302.4	5 349.3	789.0	6.317	39.55

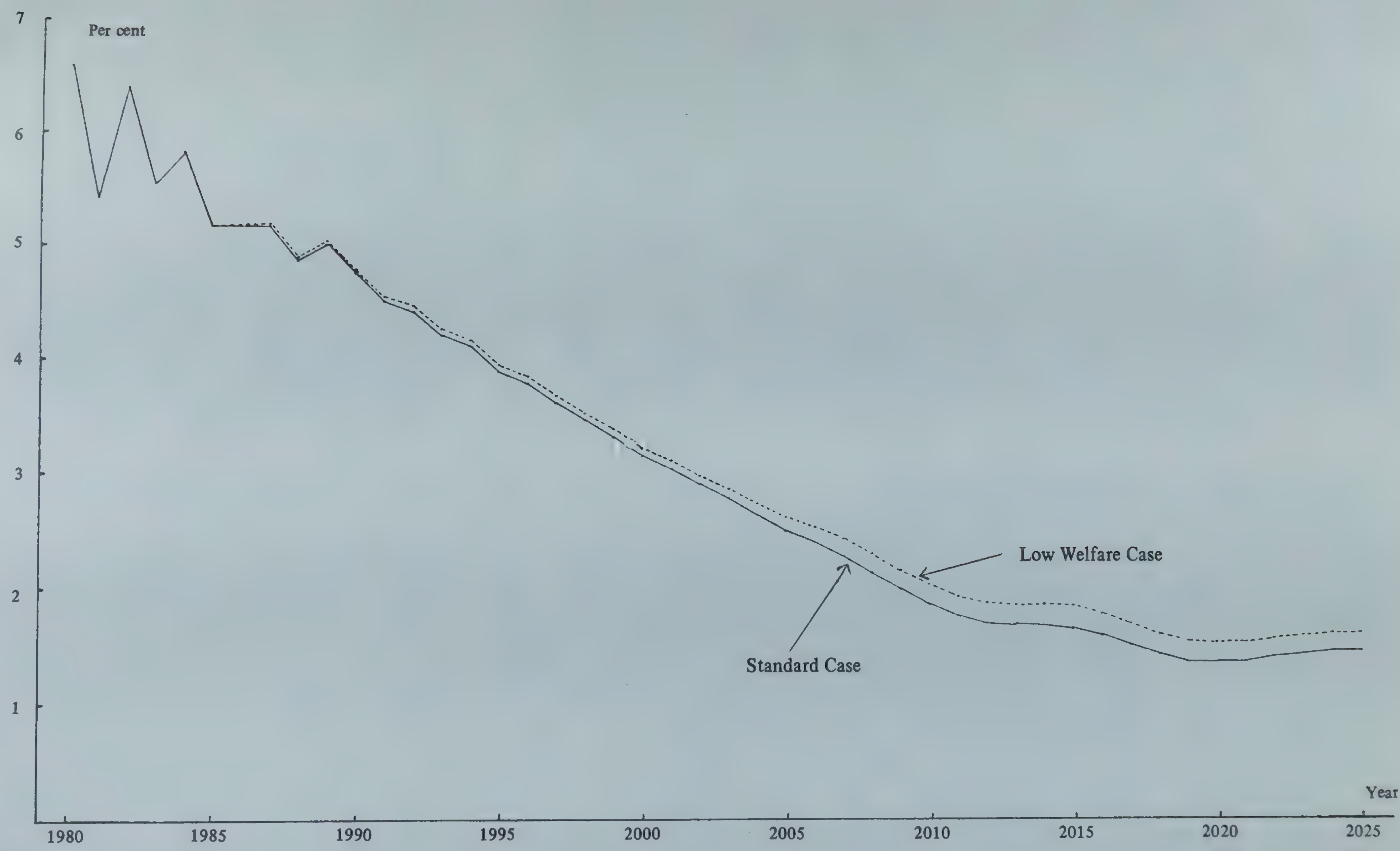


Figure XIV.24. Comparison of real GNP growth rates

Table XIV.27. Changes in the male labour force participation rate for age group 60 and over: standard and low welfare cases

(unit: per cent)

Year	Standard Case	Low Welfare Case
1980	51.81	51.81
1985	53.96	53.96
1990	53.09	53.07
1995	49.99	49.95
2000	46.63	46.55
2005	43.67	43.85
2010	42.00	42.59
2015	38.01	38.75
2020	36.14	36.85
2025	35.32	35.88

the value of KP between the Standard Case and the Faster Capital Replacement Case is relatively small. In the early 21st century it becomes more pronounced; in year 2000 the relative difference is 4.88 per cent, but in 2025 it is approximately 24.5 per cent.

Because of a slower pace of capital formation, this alternative case yields considerably smaller GNP, both nominal and real. Figure XIV.25. illustrates the difference in the annual GNPR growth rates between these two cases. It should be noted that the annual growth rate of GNPR for this alternative case falls below one per cent from 2017 onward. Moreover, *per capita* GNPR for this alternative case is substantially smaller than that for the Standard Case, especially in the early part of the next century. In the final year of simulation, *per capita* GNPR for this alternative case is 15.8 per cent smaller than that for the Standard Case. As a consequence of alternative case such slower economic growth, the level of real savings for this alternative case is distinctively lower than that for the Standard Case. (See Table XIV.9. for comparison.)

G. ALTERNATIVE TAXATION CASE

In the Standard Case, government savings become negative from the year 2004, as a result of increasing social security benefit payments. These negative savings in turn are filled in by a proportional increase in TP, TC and TI. To shed some light on the impact of alternative taxations upon both demographic and economic factors, we have conducted the following two experiments involving cases assuming negative government savings to be compensated by a proportional increase: (i) in TP and TC, and (ii) solely by an increase in TI.

Because these two alternative cases generate little pronounced effect upon demographic factors, we will examine only these impacts upon the economic side. Table XIV.29. lists computed values of GNPR and its annual growth rate for these two cases over the period 2000-2025. These results show that the first case (i.e., tax increases through TP and TC) produces lower GNPR and its growth rate, as compared with the second case. (It should be noted, however, that these alternative cases yield higher levels of GNPR and its annual growth rate than the Standard Case does). In the year 2025 the first case has a 2.6 per cent larger GNPR and a 0.13 per cent higher annual growth rate than the second. These results imply that government taxation policies to be adopted in an aging society lead to considerably different levels of economic activity.

Table XIV.28. Simulated changes in selected economic variables in the faster capital replacement rate case

Year	GNPN (trillions of yen)	GNPR (trillions of yen)	GNPR/TP (millions of yen)	S/ID (trillions of yen)	KP (trillions of yen)
1980	237.2	193.7	1.655	72.4	283.2
1985	351.6	254.3	2.106	95.5	392.1
1990	514.6	322.2	2.604	122.6	530.3
1995	732.0	392.8	3.100	151.6	698.5
2000	1 028.2	460.3	3.555	172.7	887.6
2005	1 440.2	520.0	3.966	185.2	1 086.7
2010	2 052.7	566.8	4.326	196.5	1 279.6
2015	2 818.4	602.4	4.651	196.5	1 455.2
2020	3 425.7	629.1	4.940	200.9	1 604.6
2025	3 923.8	652.1	5.219	206.8	1 742.4

Table XIV.29. Impact of alternative taxation cases upon selected economic variables

Year	*Tax increase through*			
	TP + TC		*TI alone*	
	GNPR (trillions of yen)	GNPR growth rate (per cent)	GNPR (trillions of yen)	GNPR growth rate (per cent)
2000	473.4	3.14	473.4	3.14
2005	542.5	2.50	542.7	2.52
2010	603.0	1.87	606.1	2.00
2015	655.9	1.66	663.6	1.79
2020	705.0	1.36	718.3	1.51
2025	756.4	1.45	776.2	1.58

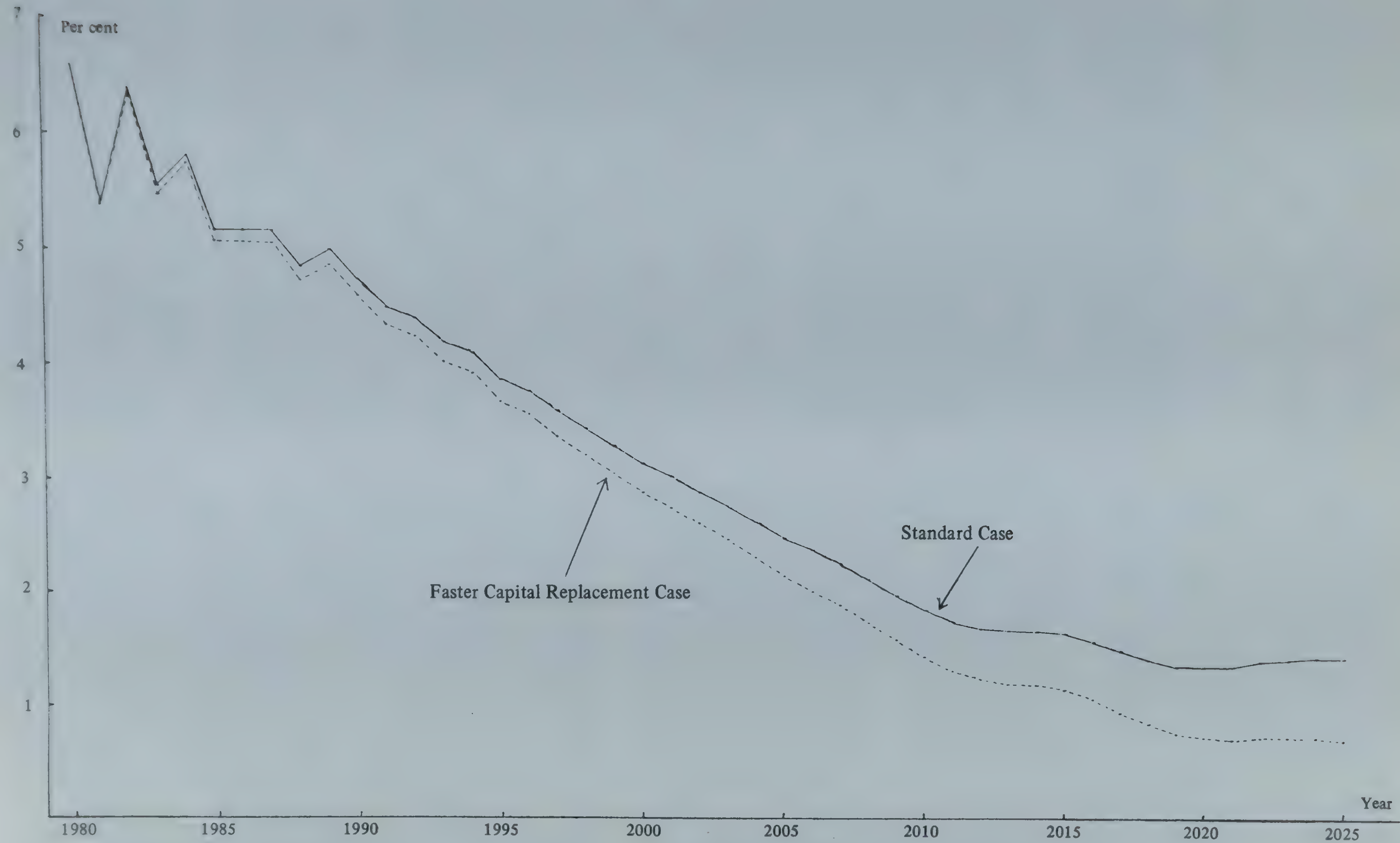


Figure XIV.25. Simulated changes in annual GNPR growth rates for two opposing cases

Chapter XV

SUMMARY AND CONCLUSIONS

The various simulation results obtained in the previous chapter have enabled us to discuss Japan's several future scenarios and to examine some of the policy implications for each scenario. To facilitate the discussions that follow, we summarize the major findings of the Standard Case.

In the Standard Case, the level of TFR tends to fall primarily due to continued economic progress and the rising age at first marriage for females. In addition to declining fertility, mortality improves considerably as a result of a rapid increase in the *per capita* medical expenditure, which is directly influenced by the national economic performance. As a consequence of lower fertility and improved mortality, the size of the Japanese population grows at a diminishing rate. After it peaks at 131.3 million persons in 2007, it begins to shrink gradually. More importantly, not only the size of the population but also its age structure changes very markedly. For instance, the percentage of the population aged 65 and over increases from 9.10 per cent in 1980 to 23.88 per cent in 2021. Moreover, during the corresponding period the percentage of the population aged 15-64 decreases from 67.39 per cent to 61.75 per cent.

This dramatic increase in the aged population and the rapid decline in the working-age population lead to rapid population aging which has extensive and intensive impacts upon the economic system including social security programmes. One of the most important impacts of the aging of the Japanese population is the slower economic growth rate. In the first two decades of simulation, the annual economic growth rate is somewhere between 4 and 6 per cent. In the next century, however, it drops to a level close to 1 per cent. Such an economic slow-down is principally attributable to the slower growth of the labour force, the product of the decreasing size of the working-age population and the lower labour force participation rates induced by improved educational enrolment, shorter hours worked, higher pension benefits, and employment structural changes.

The capital stock is affected by increased personal consumption of both medical and non-medical goods and services. The growth of personal consumption is substantially influenced by an increase in transfer payments under the social security system, due to age structural changes. It should be also stressed that this economic slow-down is very likely to be beset by rapid cost inflation induced by increasing social security contributions paid by employers. To sum up, population aging adversely affects Japanese economic growth through changes in the labour force and in capital stock.

By conducting several alternative simulation experiments, we have tested the sensitivity of the estimated model. One of the sensitivity tests has been based upon the two alternative fertility cases: High Fertility Case and Low Fertility Case. As opposed to the Standard Case, the former case has assumed a gradual recovery of the fertility level, reaching a TFR of 1.803 in the year of 2025. In the latter case, the fertility level falls slightly faster than that of the Standard Case, arriving at a TFR of 1.505 in the terminal year of simulation. The High Fertility Path yields a slower pace of population aging, while the Low Fertility Case shows a constantly growing percentage of the aged population throughout the simulation period. These alternative fertility paths produce a considerably different picture in terms of real GNP. In almost all the part of the first 35 years, GNPR for the High Fertility Case is only marginally larger than that for the Low Fertility Case. In the last two decades of the simulation period, however, the High Fertility Case produces a considerably higher value of GNPR than the Low Fertility Case.

The other alternative path considered in the present study has been based on the assumption of mortality conditions comparable to those assumed by the 1981 MHW population projection. Because the Alternative Mortality Case is based upon lower survival rates than the Standard Case, it shows a slow growth of the percentage of the population aged 65 and over, compared to the Standard Case. The alternative case, however, yields only a marginal difference in both economic and social security variables, as compared with the Standard Case.

Another alternative path incorporated in this study is based upon lower levels of pension benefits paid out. In this Low Welfare Case, the highest level of the ratio of social security benefits to national income is 44.55 per cent in 2025 in comparison to 48.70 per cent in the same year for the Standard Case. Such a lower burden in the social security system affects the

economic submodel, particularly through personal consumption and corporate income. Because the lower welfare level leads to a faster growth rate of gross savings, GNPR for this case is 4.5 per cent greater than that for the Standard Case in 2025. It should be also noted that the difference in GNPR between these two cases becomes increasingly pronounced after the turn of the century.

The case of a faster rate of capital replacement has been considered. In this case, capital stock grows at a slower pace, thus yielding a considerably lower level of GNP, and from 2017 its annual growth rate falls below a 1 per cent level. In the final year of simulation, per capita GNPR for this alternative case is 13.7 per cent smaller than that for the Standard Case.

The last sensitivity test has been undertaken with respect to two alternative taxation cases to finance negative government savings which occur primarily due to increasing social security benefit payments after the year 2004. It has been found that a tax increase through indirect taxes lead to a higher level of real GNP and its annual growth rate, as compared with alternative taxation cases.

In all of these simulation runs, *per capita* real GNP will continue to rise throughout the period under study. However, the economic growth rate of future Japan will become substantially lower, particularly in the early part of next century. The principal source of this economic slow-down is the decreasing growth rate of the labour force as a result of the sustained decline in fertility in postwar Japan. In addition to this labour-related factor, the increasing financial resources for various social security programmes would further contribute to Japan's economic-slow down in the next several decades. Moreover, the average hours worked by those in the labour force would continuously fall due to a sustained rise in real wages.

To cope with this gloomy economic prospect, various policy measures can be considered. First of all, the speed of technological progress should be accelerated. To the extent that robots or automated production methods compensate for the shortage of young workers, Japan's future economic slow-down will be considerably warded off. By using the modern technology, the utilization level of capital equipment could be maintained at a high level, while the number of hours worked by human workers decreases continuously. To facilitate such technological innovations, more resources should be allocated to research and development.

A second measure to mitigate the negative effect of the labour force is to change the present Japanese employment practice. At present, most of the business enterprises require their workers to retire at the age somewhere between 55 and 60 [43]. One major reason for this early retirement age is related to the wage system; the older the worker is, the higher the wage becomes. If the retirement age is extended, this age-based wage system causes a substantial increase in the wage bill. To make the postponement of retirement age more feasible, the wage system should be restructured, which would require more dialogue between labour unions and management. More importantly, the extension of retirement age is desirable for the following reasons. First, as shown in this study, both life expectancy and health conditions of aged workers are likely to continuously improve in the future, which in turn, would positively contribute to economic growth. Secondly, the postponement of retirement age would reduce the financial pressure derived from public pension schemes.

A third policy measure to be implemented is to update professional skills of aged workers through a variety of government vocational retraining programmes [43]. It is particularly important to note that microelectronics is likely to play an increasingly vital role in Japan's production system. Because the production mode heavily based upon electronics tends to be less physically-oriented, it seems quite suitable for old workers. Moreover, it should be stressed that vocational retraining for the aged could be provided through the use of facilities of universities and colleges which would be increasingly available due to lower fertility.

Fourthly, a desirable level of pension benefits should be examined. The present study shows a trade-off relationship between economic growth and the level of pension benefits; a higher benefit level lead to lower economic growth, and vice versa. Current pension programmes place emphasis upon both egalitarian and universal principles. To keep economic growth at a high level, however, the amount of pension benefits paid out should be adjusted by extending the pensionable age for each scheme. Furthermore, these public pension schemes should be redesigned to be more selective in the provision of their benefits. That is, although those who need financial resources in their old-age for physical reasons should be generously covered by pension schemes, those who can work should continue to stay in the labour force. As a first step toward the implementation of this policy measure, the employment of aged workers should be encouraged through effective government incentive and disincentive schemes directed toward both labour unions and management.

Fifthly, both efficiency and effectiveness of various public medical plans should be reviewed carefully. At present, these plans provide excessive medical benefits without any major qualifications. In other words, the non-constraint supply of benefits tends to create more demand for medical services. As a result, a considerable portion of such demand consists of very minor medical cases which could be cured essentially without a doctor's consultation. To reduce the social cost of medical services, an appropriate measure should be taken with regard to the coverage of each medical plan. Furthermore, it seems desirable that an increasing amount of medically-related government spending should be allocated for the improvement of preventive medical purposes.

According to the computational results of this study, the Japanese economy is likely to retain its economic strength at a considerably high level until the end of this century. Moreover, the tempo of population aging would accelerate in the beginning of the next century. For these reasons, a long-run comprehensive policy design should be developed promptly so as to minimize the difficulties likely to arise in the next several decades. Therefore, modelling work of this nature will become increasingly important as a policy analytical tool.

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Appendix A

Both Jacobi and Gauss-Seidel methods are widely used iterative techniques for solving a simultaneous equation system. The theoretical procedure for these methods can be illustrated, without a loss of generarity, on the basis of a simple case of a three-equation system.

The Jacobi Iterative Method

Let us first express three equations in the form of explicit functions as follows:

$$\left.\begin{aligned} Y_1 &= f_1\,(Y_2, Y_3, Z) \\ Y_2 &= f_2\,(Y_1, Y_3, Z) \\ Y_3 &= f_3\,(Y_1, Y_2, Z) \end{aligned}\right\} \quad (1)$$

where Y_1, Y_2 and Y_3 are endogenous variables, and Z is a vector of predetermined variables with fixed values. Then, the iterative procedure begins with the values of Y_i's computed as follows:

$$\left.\begin{aligned} Y_1^{(1)} &= f_1\,(Y_2^{(0)}, Y_3^{(0)}, Z) \\ Y_2^{(1)} &= f_2\,(Y_1^{(0)}, Y_3^{(0)}, Z) \\ Y_3^{(1)} &= f_3\,(Y_1^{(0)}, Y_2^{(0)}, Z) \end{aligned}\right\} \quad (2)$$

where $Y_i^{(0)}$ is an initial value of Y_ii, and $Y_i^{(1)}$ is a computed value of Y_i in the first round of iteration. For the k-th iteration, we obtain.

$$\left.\begin{aligned} Y_1^{(k)} &= f_1\,(Y_2^{(k-1)}, Y_3^{(k-1)}, Z) \\ Y_2^{(k)} &= f_2\,(Y_1^{(k-1)}, Y_3^{(k-1)}, Z) \\ Y_3^{(k)} &= f_3\,(Y_1^{(k-1)}, Y_2^{(k-1)}, Z) \end{aligned}\right\} \quad (3)$$

This iterative process continues until the computed Y_i's satisfy the convergence criterion as shown below:

$$\frac{Y_i^{(k)} - Y_i^{(k-1)}}{Y_i^{(k-1)}} < \epsilon \quad (i = 1, 2, 3) \qquad (4)$$

where ϵ is a sufficiently small number. (In the present study, the value for ϵ is 10^{-4}.)

The Gauss-Seidel Iterative Method

This method is a revised version of the Jacobi method. In this method, after the computed value of the i-th endogenous variable is solved in the i-th equation, this value of the i-th endogenous variable is used in the equation to follow. That is, the equation system (2) is replaced by the following equation system:

$$\left.\begin{aligned} Y_1^{(1)} &= f_1\,(Y_2^{(0)}, Y_3^{(0)}, Z) \\ Y_2^{(1)} &= f_2\,(Y_1^{(1)}, Y_3^{(0)}, Z) \\ Y_3^{(1)} &= f_3\,(Y_1^{(1)}, Y_2^{(1)}, Z) \end{aligned}\right\} \quad (2')$$

Then, the equation system (3) is changed into the following system:

$$\left.\begin{aligned} Y_1^{(k)} &= f_1\,(Y_2^{(k-1)}, Y_3^{(k-1)}, Z) \\ Y_2^{(k)} &= f_2\,(Y_1^{(k)}, Y_3^{(k-1)}, Z) \\ Y_3^{(k)} &= f_3\,(Y_1^{(k)}, Y_2^{(k)}, Z) \end{aligned}\right\} \quad (3')$$

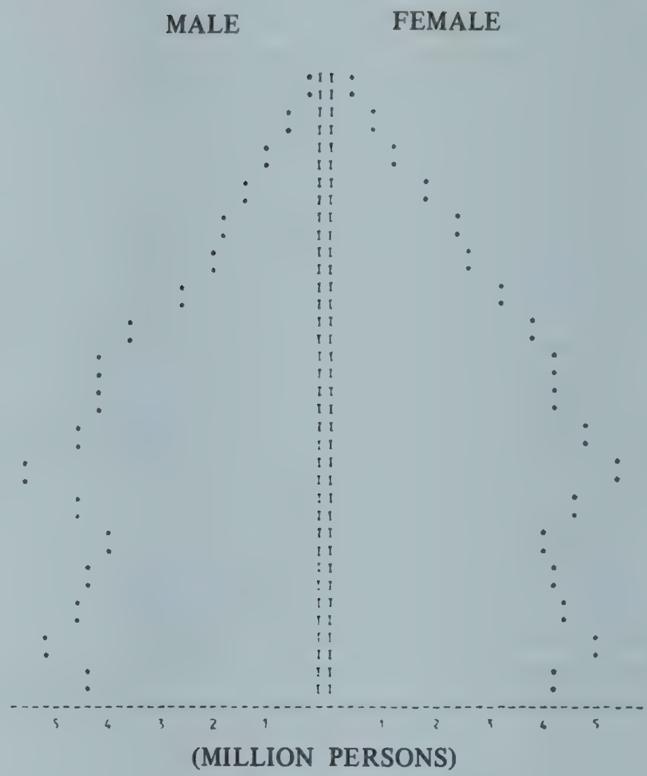
In the linear equation system, it is known that the convergence speed in the Gauss-Seidel method is usually faster than that in the Jacobi method. In the non-linear equation system, however, it is often the other way round. In our study, we have tried both iterative methods, and have found that the present model converges faster by the Jacobi method than by the Gauss-Seidel method. For this reason, we have chosen the Jacobi method for this study.

Appendix B

. . . 1980 . . .

AGE	TOTAL	MALE	FEMALE
85 +	530.	172.	358.
80–34	1094.	418.	676.
75–79	2038.	849.	1188.
70–74	3025.	1319.	1706.
65–69	3967.	1745.	2222.
60–64	4468.	1948.	2520.
55–59	5617.	2514.	3103.
50–54	7204.	3550.	3654.
45–69	8095.	4037.	4059.
40–44	8343.	4163.	4180.
35–39	9207.	4599.	4609.
30–34	10778.	5426.	5352.
25–29	9047.	4549.	4498.
20–24	7846.	3963.	3882.
15–19	8277.	4227.	4050.
10–14	8965.	4599.	4366.
5– 9	10038.	5147.	4891.
0– 4	8521.	4370.	4151.

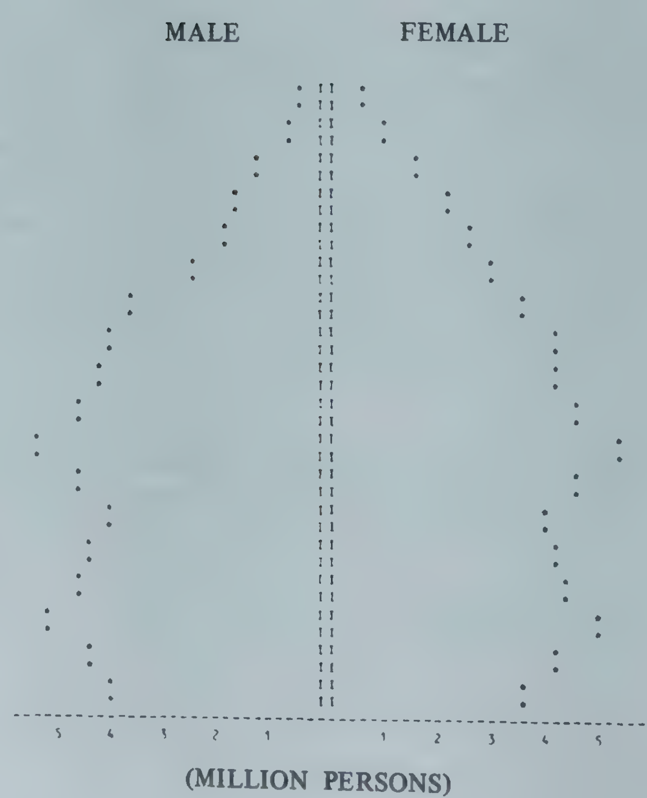
THOUSAND PERSONS



. . . 1985 . . .

AGE	TOTAL	MALE	FEMALE
85 +	796.	268.	528.
80–84	1412.	541.	871.
75–79	2447.	1006.	1441.
70–74	3509.	1483.	2026.
65–69	4240.	1772.	2467.
60–64	5311.	2377.	2934.
55–59	7010.	3425.	3585.
50–54	7951.	3943.	4008.
45–49	8246.	4100.	4146.
40–44	9140.	4556.	4584.
35–39	10727.	5393.	5334.
30–34	9015.	4528.	4487.
25–29	7822.	3947.	3875.
20–24	8255.	4211.	4044.
15–19	8953.	4590.	4363.
10–14	10028.	5140.	4888.
5– 9	8500.	4358.	4142.
0– 4	7396.	3802.	3594.

THOUSAND PERSONS



. . . 1990 . . .

AGE	TOTAL	MALE	FEMALE
85 +	1162.	400.	762.
80–84	1753.	669.	1084.
75–79	2907.	1168.	1740.
70–74	3813.	1537.	2276.
65–69	5021.	2186.	2835.
60–64	6709.	3257.	3453.
55–59	7765.	3825.	3940.
50–54	8124.	4024.	4100.
45–49	9052.	4502.	4551.
40–44	10660.	5352.	5308.
35–39	8976.	4502.	4474.
30–34	7798.	3930.	3868.
25–29	8235.	4196.	4039.
20–24	8935.	4576.	4359.
15–19	10017.	5132.	4885.
10–14	8492.	4353.	4139.
5– 9	7376.	3792.	3584.
0– 4	6955.	3575.	3380.

THOUSAND PERSONS

. . . 1995 . .. .

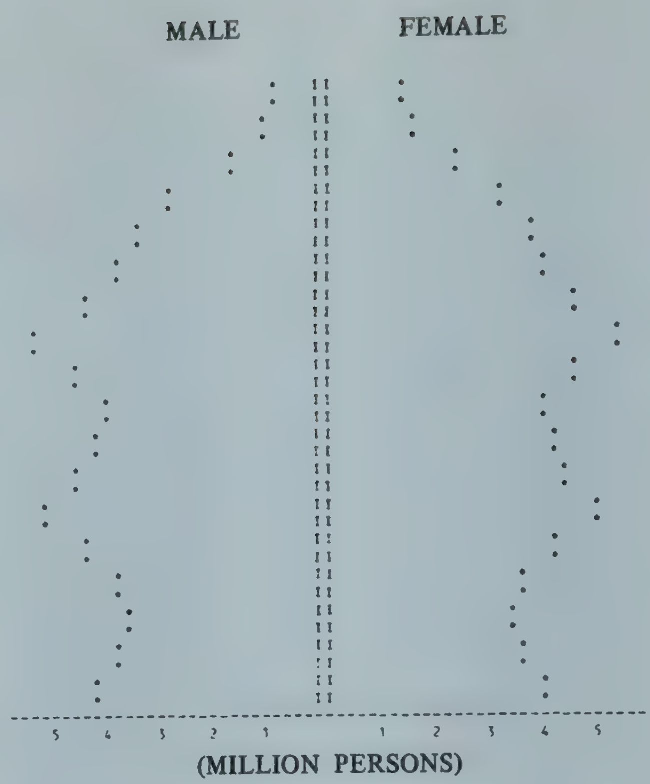
AGE	TOTAL	MALE	FEMALE
85 +	1590.	552.	1038.
80–84	2113.	793.	1319.
75–79	3211.	1236.	1976.
70–74	4558.	1925.	2633.
65–69	6330.	3010.	3320.
60–64	7487.	3652.	3835.
55–59	7954.	3919.	4034.
50–54	8936.	4433.	4504.
45–49	10573.	5300.	5273.
40–44	8925.	4472.	4453.
35–39	7769.	3909.	3859.
30–34	8213.	4179.	4034.
25–29	8916.	4562.	4355.
20–24	10001.	5119.	4882.
15–19	8484.	4346.	4137.
10–14	7370.	3788.	3581.
5– 9	6935.	3566.	3369.
0– 4	7328.	3767.	3562.

THOUSAND PERSONS

. . . 2000 . . .

AGE	TOTAL	MALE	FEMALE
85 +	2026.	701.	1325.
80–84	2349.	846.	1503.
75–79	3855.	1563.	2292.
70–74	5744.	2657.	3087.
65–69	7064.	3381.	3683.
60–64	7682.	3746.	3936.
55–59	8754.	4322.	4432.
50–54	10447.	5226.	5221.
45–49	8854.	4430.	4424.
40–44	7726.	3884.	3842.
35–39	8183.	4158.	4025.
30–34	8894.	4545.	4349.
25–29	9982.	5104.	4878.
20–24	8472.	4337.	4135.
15–19	7363.	3783.	3580.
10–14	6929.	3562.	3367.
5– 9	7307.	3757.	3550.
0– 4	7849.	4034.	3815.

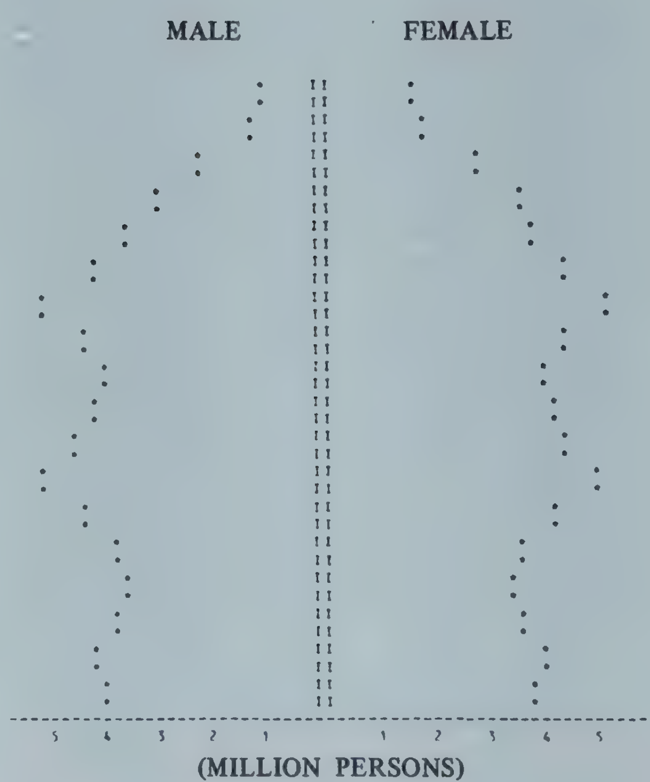
THOUSAND PERSONS



. . . 2005 . . .

AGE	TOTAL	MALE	FEMALE
85 +	2390.	804.	1586.
80–84	2824.	1078.	1746.
75–79	4837.	2152.	2686.
70–74	6409.	2985.	3425.
65–69	7247.	3467.	3779.
60–64	8455.	4130.	4325.
55–59	10240.	5100.	5140.
50–54	8747.	4367.	4379.
45–49	7665.	3849.	3817.
40–44	8138.	4131.	4007.
35–39	8861.	4522.	4340.
30–34	9957.	5035.	4872.
25–29	8455.	4324.	4131.
20–24	7353.	3774.	3578.
15–19	6922.	3557.	3366.
10–14	7300.	3753.	3547.
5– 9	7826.	4024.	3802.
0– 4	7484.	3847.	3639.

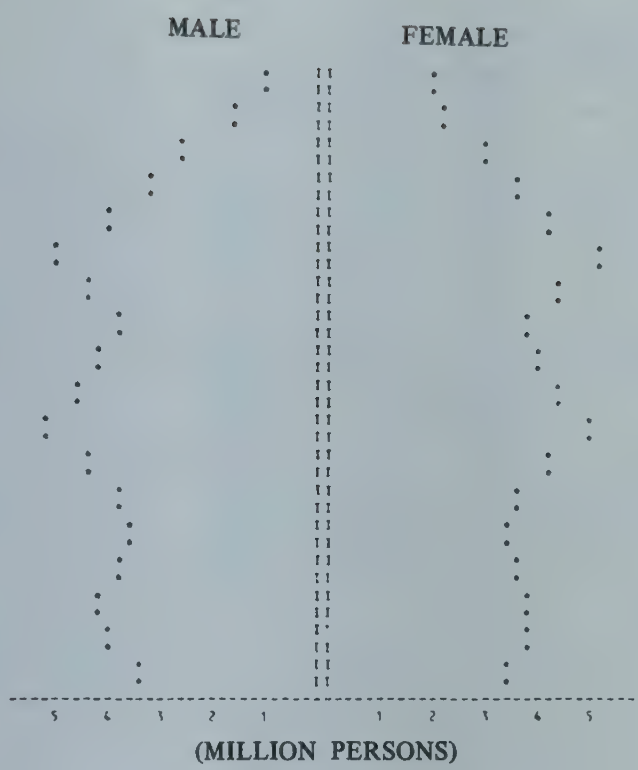
THOUSAND PERSONS



. . . 2010 . . .

AGE	TOTAL	MALE	FEMALE
85 +	2850.	983.	1867.
80–84	3517.	1475.	2042.
75–79	5394.	2415.	2979.
70–74	6572.	3059.	3513.
65–69	7973.	3822.	4151.
60–64	9897.	4880.	5018.
55–59	8568.	4258.	4310.
50–54	7573.	3795.	3778.
45–49	8075.	4094.	3981.
40–44	8813.	4493.	4321.
35–39	9920.	5059.	4861.
30–34	8434.	4307.	4126.
25–29	7338.	3763.	3575.
20–24	6913.	3549.	3364.
15–19	7294.	3748.	3546.
10–14	7819.	4020.	3799.
5– 9	7462.	3837.	3625.
0– 4	6598.	3391.	3207.

THOUSAND PERSONS



. . . 2015 . . .

AGE	TOTAL	MALE	FEMALE
85 +	3469.	1282.	2187.
84–84	3917.	1653.	2264.
75–79	5526.	2473.	3053.
70–74	7227.	3369.	3857.
65–69	9344.	4523.	4822.
60–64	8273.	4069.	4205.
55–59	7420.	3701.	3719.
50–54	7978.	4037.	3941.
45–49	8744.	4452.	4292.
40–44	9865.	5026.	4839.
35–39	8402.	4285.	4117.
30–34	3720.	3749.	3571.
25–29	6899.	3538.	3361.
20–24	7283.	3739.	3544.
15–19	7812.	4014.	3798.
10–14	7455.	3833.	3623.
5– 9	6579.	3383.	3196.
0– 4	5993.	3080.	2912.

THOUSAND PERSONS

. . . 2020 . . .

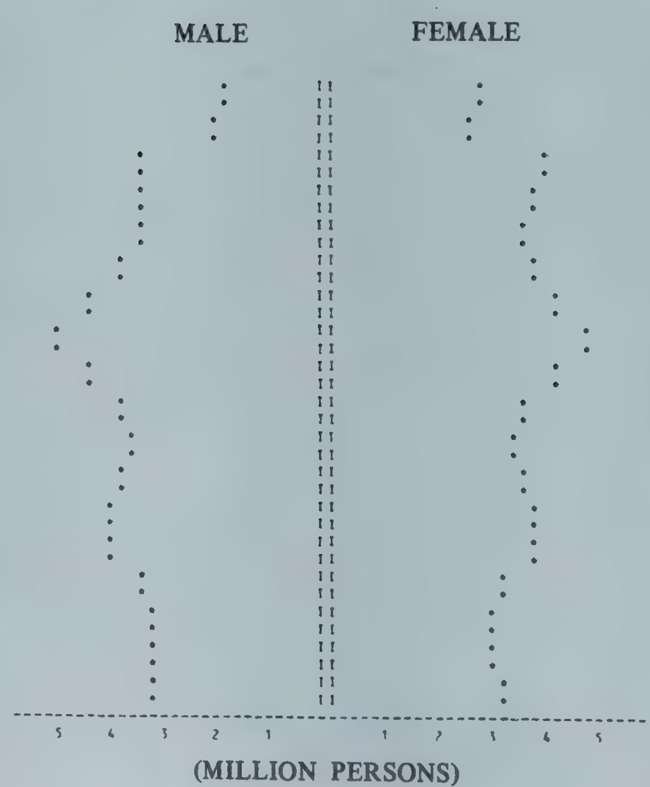
AGE	TOTAL	MALE	FEMALE
85 +	4011.	1526.	2484.
80–84	4005.	1689.	2316.
75–79	6069.	2720.	3349.
70–74	8488.	3999.	4489.
65–69	7799.	3764.	4035.
60–64	7168.	3539.	3629.
55–59	7818.	3938.	3879.
50–54	8640.	4390.	4250.
45–49	9788.	4981.	4807.
40–44	8356.	4258.	4098.
35–35	7292.	3730.	3562.
30–34	6882.	3525.	3357.
25–29	7269.	3728.	3541.
20–24	7801.	4005.	3796.
15–19	7449.	3827.	3621.
10–14	6573.	3379.	3194.
5– 9	5975.	3072.	2903.
0– 4	5933.	3049.	2883.

THOUAND PERSONS

. . . 2025 . . .

AGE	TOTAL	MALE	FEMALE
85 +	4335.	1668.	2667.
80–84	4389.	1853.	2536.
75–79	7160.	3245.	3914.
70–79	7065.	3317.	3748.
65–69	6761.	3276.	3485.
60–64	7552.	3766.	3786.
55–59	8467.	4284.	4184.
50–54	9669.	4910.	4759.
45–49	8290.	4219.	4071.
40–44	7252.	3706.	3546.
35–39	6856.	3507.	3349.
30–34	7251.	3714.	3537.
25–29	7786.	3993.	3793.
20–24	7438.	3819.	3620.
15–19	6567.	3374.	3193.
10–14	5970.	3069.	2901.
5– 9	5916.	3042.	3874.
0– 4	6179.	3176.	3003.

THOUSAND PERSONS



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Part Four

ECONOMIC-DEMOGRAPHIC MODELS: COMPARATIVE ANALYSIS

by

David Demery
Department of Economics
University of Bristol

Chapter XVI

MODEL AND ECONOMIC-DEMOGRAPHIC INTERACTION

A. RECOGNITION OF INTERACTION

For a significant period of time, and especially since the 1974 World Population Conference in Bucharest, there has been a widespread recognition of the importance of economic-demographic interaction, both for development and demographic policies. This recognition is central to the reports in this volume, which represent three views of economic-demographic interaction in three countries of the ESCAP region. Significantly the countries are at very different stages of development and demographic transition.

In Table XVI.1 the economic and demographic characteristics of each of the three countries are presented for comparison. Japan and Indonesia have relatively large populations. The three countries represent convenient stages in the development process, with Indonesia and Japan at the extremes (as crudely measured by GNP *per capita* in $US (1970)) and the Republic of Korea an intermediate case.

Each demographic indicator reported in Table XVI.1 also points clearly to the stage of demographic transition attained by the three countries. Indonesia has the highest birth, death and gross reproduction rates and the lowest life expectancy at birth. Japan is at an advanced stage of transition, its crude birth rate being less than one-third of that in Indonesia, with a life expectancy at birth of over 73 years. The Republic of Korea, again by reference to all four demographic indicators reproted, is at an intermediate stage.

The fact that each country stands at a different stage of its economic and demographic development adds much interest to this study. The models required to capture the important economic and demographic relationships are likely to be very different between the countries. Moreover the perceived problems associated with economic-demographic interaction are likely to differ in each country. The problems of population growth in Indonesia are seen largely in terms of overall pressure on resources; in the Republic of Korea more attention is devoted to issues of internal migration whilst in Japan population aging and its related economic effects are seen as the major problems facing the relevant Japanese policy-makers.

But all three models conceive of the problem of economic-demographic interaction as necessarily complex and they allow for a full (i.e. two-way) interaction of economic and demographic factors in contrast to the early emphasis in the literature or the effects of fertility changes on economic development. (e.g. Coale and Hoover, Enke etc). They also address the likely effects of economic growth and development on population and its structure.

Table XVI. Key economic and demographic indicators

	Population Size (million)	GNP *per capita* $US (1970 market prices)	Crude Birth Rate (per 1000)	Crude Death Rate (per 1000)	Gross Reproduction Rate	Life Expectancy at Birth
Indonesia						
1970		80	47.1	18.3	2.70	47.5
1976	130.4					
The Republic of Korea						
1970		330			2.53	60.6
1975	34.7		27.6	8.6		
Japan						
1970		1 920			1.05	73.3
1980	116.852		13.6	6.2		

Sources: Country reports; T.P. Dyson, C.L.G. Bell and R.H. Cassen (1978).

B. USE OF MODELS

There is – amongst both practising economists and demographers – a suspicion of large-scale models. Perhaps too much was at first claimed of them by their builders. In order to minimize possible misunderstandings of the three models presented in this report, some general principles for interpreting the results are presented in this section.

Many models – both economic and demographic – are designed primarily for forecasting. Others are simulation models, in which the effects of alternative policy measures are compared under a given state of knowledge. In simulation exercises it is the relative behaviour of the system under alternative policy regimes that is of importance, rather than any single outcome taken in isolation. The strength of the models presented in this volume is not in forecasting precisely the future time paths for economic and demographic variables; it is rather in providing a framework for policy analysis. And this framework necessarily reflects the current state of knowledge of economic and demographic relationships and their interaction. Models can never capture all the feature of economic and demographic processes, even insofar as these are understood. They may conveniently be defined as attempts to understand the interaction of those relationships that are believed to hold. Indeed the art of successful modelling is in the choice of salient and important relationships to include and less relevant ones to exclude from the model structure. A clear advantage of using large-scale computer models of the type adopted in this report is that large numbers of such 'salient' relationships can be handled and their interaction analysed.

Two important conveats must be underscored at the outset. First there is a real danger that modelling will proceed ahead of a proper and thorough understanding of the individual relationships used. Ideally each individual relationship should be subjected to rigorous econometric investigation; and where this is not possible (due to lack of data for example) well-accepted regularities should be incorporated rather than more speculative conjectures unsupported from other sources. Modelling and empirical research must proceed in tandem: the former exploring the interactions amongst known relationships whilst the latter is continually challenging currently-held theories and throwing up alternatives. The three studies in this report reflect to varying degrees the current state of knowledge in economic-demographic interaction.

Secondly because models are by construction abstractions and approximations, they must be used to handle only a limited set of questions. Non-quantifiable phenomena cannot be included for example and these may dominate in the long-run. The irrelevance of 'traditional' inputs in explaining growth is an interesting and relevant illustration of this point. (See Kuznets (1966) who argued that less than 10 per cent of growth of the now developed economies can be explained in the statistical sense by theoretically conventional inputs).

For these and other reasons Hawthorn has described models as 'necessary but clearly no longer sufficient' (G. Hawthorn 1978, p. 6). But with these limitations in mind computer models, carefully handled, can provide interesting insights into economic-demographic processes that may not be intuitively obvious or derivable using analytical methods. Moreover models may themselves highlight specific key relationships and actually promote further study into the empirical basis for those relationships. Models, in this view are not "final products" but attempts to "take stock" of the state of the art by incorporating current knowledge into a general system, which allows all individual relationships a place in affecting the whole.

C. CHOICE OF PARADIGM

Given then that modellers are limited by the current state of knowledge and that they can only answer a limited set of questions it is doubly important to select an appropriate "paradigm" or "central core" for modelling. This choice then depends both upon the knowledge of individual relationships and the use to which the model is to be put.

There are some who would argue that so very little is really understood of longer-term relationships that economic-demographic modelling is of only limited validity. The historically unprecedented changes in the populations of the developing countries leads to some uncertainty about likely future trends. The present-day developed countries may provide only a very limited framework for analysis.

Moreover many important interactions between economic and demographic processes occur over very long periods, perhaps well beyond the interest and horizons of most planners. They may be of academic interest only. Simon (1976) for example has argued that "for a representative Asian LDC . . . moderate population growth (doubling over 50 years) has better long-run performance than either fast population growth (doubling over 35 years or less) or slow population growth (doubling over 200 years)". The "long-run" performance to which Simon refers is understood to be

between 120 and 180 years, hardly of any immediate policy relevance. Over shorter periods, low fertility paths dominate. Planners of course may be sceptical of such long-run analyses both because of lack of interest in such perspective exercises and because they have little confidence in the state of knowledge of such long-run interactions. However prospective planning is a valued exercise, and whilst more pressing problems may mould actual policies, the long-run trends and implications of current policies are of considerable concern to policy-makers.

Alternatively economic-demographic interaction may be imperceptible over the short-periods typical of planning exercises. Thus Mcnicoll (1975) asserts that "models in the Keynesian tradition, in which production and the use of resources are determined by aggregate demand rather than supply are not of much relevance in development studies" (p. 649). In addressing long-run questions neo-classical models have dominated the literature. Coale and Hoover applied a Harrod-Domar production function in analysing periods of time less than 15 years, when the labour force could be considered constant; but for longer periods a Cobb-Douglas function was required.

The nature of the questions being asked of a model, the time frame of the analysis and the choice of paradigm are inextricably interlinked. If important demographic-economic effects are likely over fairly short periods (migration from rural to urban areas is one such area; educational requirements of a sudden "baby boom" is another), short-run models (even of the Keynesian type) may be constructed to provide relevant answers. Long run interactions (like the effects of aging on savings behaviour, or the influence of income on a population's fertility behaviour) will naturally require an alternative approach. To some extent, as we shall see in the following chapter, the model structures set out in this report reflected the questions being asked of them. Indonesian and Korean models were really looking over a typical planner's time horizon; The Japanese model was in the tradition of a long-run perspective exercise.

Precisely how each country team designed their models will be the subject of the next chapter. There are however some general issues which the country experts had to consider. These arise in attempting to model the economic behaviour of the three countries. The modellers, explicitly or implicitly, resolved the following:

(a) Should the model provide detailed sectoral analysis or should it be aggregative in character?

(b) Should the model specify supply and demand functions for labour and output or adopt *ad hoc* specifications?

(c) Should labour and product markets clear?

(d) If the answer to (c) is "no", how should disequilibrium be modelled?

(e) How is the foreign sector to be included?

The intellectual tradition in 'western model-building' has been profoundly influenced by the fact that such models have been constructed to analyse business cycle phenomena, rather than questions of economic growth. Such models might emphasise disequilibrium and effective demand constraints. In contrast the modelling structure one would expect in answering longer-term questions would involve a more prominent role for aggregate supply and equilibrium analysis.

In practice the models have adopted somewhat mixed strategies in answer to these questions. Frictions, of one sort or another which inhibit equilibrating forces are present in all three models. In that sense the answer to (c) above is "no", though alternative answers have been provided for labour and product markets. The issues raised are certainly controversial ones in the relatively calmer waters of business cycle analysis. They ought, perhaps, to be less central in the context of economic-demographic interaction.

Chapter XVII

COMPARISONS OF MODEL STRUCTURES

The design of economic-demographic models has been seen to be related closely to the questions being asked of the model. Models used in relatively short-run planning exercises will look rather different from those whose purpose is to provide a long-run perspective. The model structures we compare in this chapter differ largely for these reasons. We focus separately in this chapter on the assumptions adopted concerning economic and demographic behaviour, and leave to the next chapter a closer analysis of the economic-demographic linkages.

A. DEMOGRAPHIC SUB-MODELS

The approaches adopted in each of the three studies to demographic modelling are broadly similar: fertility and mortality functions are first estimated and computed, and model life tables (sometimes appropriately adjusted) are used to provide a complete breakdown of population by age and sex. Differences occur in the fertility and mortality functions used. In the country-specific discussions that follow we include discussion of education and manpower modelling.

(a) *Indonesia*

The Indonesian modellers made the total fertility rate a function of income, education and the share of the population engaged in agriculture. Child mortality is a function of education, expenditure per household, the birth month and age of the mother (together with a rural-urban dummy). Using model life tables together with the fertility and mortality functions, the age/sex composition of the population is derived.

Three indicators of education are adopted in the Indonesian model: the proportion of adults who have never had any education, the proportion of adults finishing at least junior high school and the proportion of adults finishing at least elementary school. The first two are used as explanatory variables in the fertility function and the last is adopted in determining child mortality.

The second two (elementary and junior high school) are also functions of total fertility and income (lagged to maintain the recursive character of the model). The first educational indicator listed is exogenous.

Labour force participation rates for males and females are set exogenously (usually time-trended in some way). More importantly, fertility does not have any influence on female participation. The share of the agricultural population in the total is proportional to the share of total employment engaged in agriculture. The former is an important determinant of fertility.

(b) *The Republic of Korea*

In the Korean model, life expectancy at birth for females is estimated (using pooled Japanese and Taiwanese data) as a function of *per capita* income. Male life expectancy at birth and the survival rates are computed from modified model life tables. Given the survival rates, the number of fecund age (15-44) females is computed. The total fertility rate is determined by a simple time trend supplemented by regional effects. Age specific fertility rates are determined from the total fertility rate and the mean age at childbirth (which is a function of income, education and a rural-urban dummy).

The size of the urban population is determined by the urbanization rate, estimated as a function of the average productivity of labour. Total internal migration is computed and exogenous propensities yield the age-sex composition of migrants. Unlike the other models, the Korean model explicitly accounts for emigration, though it is determined exogenously. Family size by region (a function of time and total fertility) together with population by age and sex determine the number of families formed.

Two indices of education were adopted in the Korean case: the secondary school enrolment rate and the proportion educated to high school level and above. The former is a function of the age structure of the population and *per capita* income; the latter is similarly modelled with a time trend in place of the income term. Labour force participation rates are determined as functions of age and the rate of change of average labour productivity for the male population and as functions of age, fertility level and school enrolment of the relevant population for females.

(c) *Japan*

In the Japan model, the total fertility rate depends upon the women's age at first marriage, the labour force

participation rate for women aged between 25 and 34 years and *per capita* real GNP. The first of these influences, age of first marriage, is itself a function of educational enrolment of women aged between 15 and 24 years and the ratio of males (aged 20-44) to females (aged 15 to 39).

Male and female life expectancies at birth depend upon *per capita* medical expenditure and an *ad hoc* procedure is adopted to determine the age-specific fertility rates from total fertility. Survival rates are derived from a suitably modified life table. Household size is a linear function of real GNP *per capita*.

The labour force participation rate for prime-aged males (25-59 years) is assumed constant. That for younger males is linearly related to the level of educational enrolment, whilst the participation rate for old males depends upon level of pension benefits (negatively) and demographic composition. Participation rates for females aged 25-44 and 45-54 are constant (and exogenous). For younger females participation depends on demographic variables and educational enrolment; the participation rates of older females (55 and over) is a function of demographic factors and the proportion of self-employed to total employment in productive activities. Male and female enrolment rates are exogenously determined.

B. COMPARISON OF DEMOGRAPHIC SUB-MODELS

Whilst the approaches adopted differ in detail, the basic modelling strategies were similar: specify fertility and mortality functions (or life expectancy at birth) and refer to model life tables to complete the demographic detail. There were important differences in the way fertility was modelled by the country experts and in the interaction between demographic, manpower and labour-force participation components. These are set out in Table XVII.1.

Interestingly the exogenous components differ in the three models. In the Indonesian model labour force participation is exogenous; educational enrolment is exogenous in Japan and fertility is exogenous (time-trended) in the Korean model. Fertility is not affected by the participation rates of females in the Republic of Korea and Indonesia, but in the Korean case fertility does influence labour force participation of females. Fertility has no direct effect on the participation of females in the Indonesian and Japanese models. Demographic effects on education are allowed for only in the Indonesian case: fertility has a depressing effect on both the proportion enjoying elementary and junior high school education. The reasons for this were not fully spelt out. The argument runs as follows: "given the same level of economic development the smaller number of population will result in a high level of education." The suggestion here is that there are fixed resources for educational expenditures, and these will cover more of a smaller population than a larger one. This is clearly of limited use to educational planners who may wish to vary their expenditures depending on demographic changes. The nature of demographic-economic interaction (including manpower/education and labour force participation) in each case will be analysed in more detail in the following chapter.

The modellers were very much aware of the weaknesses and limitations of the demographic sub-models. Aggregative models of this sort must inevitably lose detail. But in some cases the demographic models could not answer important demographic and related policy questions. In Indonesia, for example the experts admitted that "The model left out important problems of population distribution between Java and outside Java." The Korean model focuses on urban migration problems, but the application of exogenous age-sex

Table XVII.1. Demographic, manpower and labour force participation interaction

Determinants of:	Indonesia	The Republic of Korea	Japan
Fertility	Income, Education Proportion Agricultural	Time trend	Age at first marriage Participation rate (female); Income
Education	Income Fertility	Income	Exogenous
Labour Force Participation	Exogenous	Labour productivity (male); Fertility, education (female)	Education Pensions (male); Self-employment (female)

specific migration propensities prevents analyses of policies which may affect these propensities. Whilst further education is an important determinant of fertility in the Japanese model (through its effects on the age of first marriage) there is no effort to model education (enrolment is simply exogenous).

There are also problems of balance in the detail required. This is particularly the case in the Korean model, whose demographic component has a regional dimension, but whose economic sub-model is highly aggregative. These problems in modelling generally reflect the nature and availability of data.

C. ECONOMIC SUB-MODELS

The modelling strategies for the economic sub-systems were quite different in the three studies. Not only were there differences in detail relating to country-specific factors, but the modellers adopted alternative "paradigms" in their attempts to map out the important economic relationships. Briefly, the Indonesian model is sectoral in character; the Korean model is mainstream Keynesian whilst that of Japan is essentially neo-classical with some "Keynesian" features.

Again the procedure in this section will be to outline the economic sub-models for each country separately and draw conclusions at the close. Whilst computer technology enables the modeller to solve fairly large equation systems numerically, a loss of an intuitive grasp of the model may result. One of the purposes of this section is to set out the broad characteristics of each model to underline the principle economic theories being applied.

(a) *Indonesia*

The Indonesian economic sub-model makes sector-specific assumptions concerning the determinants of output. This has many obvious advantages, especially in a planning context. The views of sector experts can be more easily incorporated into the model and its performance may be more easily understood and be of more immediate interest to the planner. It has much in common with a typical "planning model", in which sectoral targets are set first and subsequently capital requirements and funding implications derived. Moreover the high degree of disaggregation (especially in agriculture) is a feature of the Indonesian model that planners generally find desirable.

There are no *a priori* reasons to believe that all markets and sectors in any economy will be in identical disequilibrium regimes simultaneously. If modellers believe that markets may not clear, excess supplies in some markets may exist side by side with excess demands in others. The Indonesia modelling strategy – the sector specific approach – allows the modeller considerable flexibility in this regard. Intuition and judgement are combined with the available empirical evidence in deciding which approach is appropriate for each sector. Some agricultural sectors (like rice for example) are supply determined in the model whilst others (fisheries and animal husbandry) are demand determined.

Table XVII.2. Determinants of key sectors' output: Indonesia

Sector	Supply or Demand Constrained
Irrigated Rice	Supply
Non-irrigated Rice	Supply
Other Food Crops	Demand
Tree Crops	Supply
Fisheries	Demand
Animal Husbandry	Demand
Construction	Demand
Manufacturing	Supply

In Table XVII.2 we present an outline of the determinants of the key productive sectors' output. On the supply side, constraints take the form of land (rice and tree crops) or capital (manufacturing). Labour is naturally not seen as a limiting force on output. No overall supply constraints are imposed: these may be important, especially in respect of land-use in agriculture.

Key productive sectors are thus modelled by either supply or demand factors. Other sectors (notably the service sectors) are linked to the output of the key sectors. Input-output analysis is not applied: the model simply related linearly the service and utility sectors' output to the aggregate value added of agriculture, manufacturing, mining and quarrying.

Employment is determined by fixed elasticities which are assumed to remain unchanged over the simulation period. The demographic model provides the total supply of labour. Any excess supplies of non-agricultural labour are 'mopped up' in the agricultural sector. In this way the 'labour market' is always in equilibrium with no unemployment arising from demand deficiency. (i.e. there is only "frictional" and "structural" unemployment). Thus – in marked contrast to a "Keynesian" approach – the Indonesian model allows commodity markets to be in "disequilibrium" whilst the labour markets clear.

An alternative (though perhaps less obvious and less realistic) interpretation of this approach to modelling the sectors' outputs is as follows: where a sector's output is supply determined, demand is infinitely price elastic, so a change in supply is accommodated by a change in demand. Similarly, changes in demand in sectors which are demand-determined are accommodated by supply adjustments. According to this interpretation, commodity markets also clear in the Indonesian case.

The obvious weakness of the Indonesian approach is that linkages between the sectors are generally ignored and these linkages are of more importance, perhaps, in the disequilibrium context. If the disequilibrium interpretation is put on sector-modelling, excess demands in some sectors may have implications for output elsewhere. For example the failure of households to purchase the rice they would like (at given income levels) might lead to adjustment to their other purchases (especially other foods). Such spill-over effects are notoriously difficult to isolate and model and it is not surprising that the Indonesian modellers choose to ignore them. Other more conventional inter-sectoral linkages associated with intermediate use are also ignored, which is less easily justified on theoretical grounds in sectoral models. In the Indonesian case, data limitations were the overriding consideration.

(b) *The Republic of Korea*

The economic sub-model in the Korean case is conventionally Keynesian. Private consumption, expressed in *per capita* equivalent adult terms, is a function of current *per capita* GNP and lagged consumption. Other components of aggregate demand are either proportional to income or private consumption, or set exogenously. In particular the balance of payments is proportional to GNP and exports are derived residually once imports are known. Output adjusts to maintain equilibrium in the goods market in a conventional "Keynesian cross' fashion.

Values added by sector are derived through the application of a dynamic conversion matrix, where the dynamic characteristics of each element of the matrix are derived from data available for the 1970s only.

Again in line with the "Keynesian" approach adopted, the labour market is subject to unspecified frictions which lead to alternative disequilibrium regimes. In particular, the Korean economy is permitted to move into an excess demand regime for labour with output unaffected. Employment rules are adopted for excess supply and demand regimes. In the former, firms hoard some of the excess supplies in anticipation of a recovery of demand, though expectations are not formally modelled. In cases of excess demand, only structural/frictional unemployment (of 3 per cent) arises. These assumptions imply that actual labour productivity will automatically rise when firms fail to engaged the labour they require to produce the output demanded. Productivity is reduced when firms hoard in periods of excess supply. The cyclical pattern of productivity that emerges is one that has received empirical support from 'western' economies. The Korean modellers do not formally justify the assumptions: no supply-side model is introduced to justify the approach, and output is entirely demand-determined.

The modelling of labour productivity in the Korean has important side effects. changes in economy-wide productivity will alter the rate of urbanization and the movements in rate of change of productivity influence male labour force participation rates.

Policy options are introduced through the control of investment expenditures. Government consumption is proportional to private consumption and no adjustment is made when changes occur in the numbers enrolling for secondary and higher education.

(c) *Japan*

In the Japanese model output is supply determined using a fairly othodox neoclassical framework. An aggregate production function, which makes some allowance for vintage effects on capital efficiency, determines the level of output. The representative firm's demand for labour depends on the level of output and on relative prices (the wage rate relative to the GNP deflator). The demand for labour could be made to adjust to labour supplies (from the demographic sub-model) through wage adjustments, but such adjustments are not made. In contrast wages are assumed not to adjust instantaneously to clear the labour market, but are determined instead by a Phillips-type relation. Given the level of wages, output and employment are determined (though in fact all three are simultaneously determined in the Japanese case).

Thus whilst the model is neoclassical in some respects (adopting a vintage Cobb-Douglas production function) the labour market is slow to clear. In practice unemployment stays over one million throughout the simulation period in the basic prospect, indicating that labour supply is always in excess of labour demand. This is fortuitous as the Japanese model has no provision for the possibility of excess demand for labour, in which

case employment (and therefore output) would be constrained by available labour supplied.

However the number of hours worked per worker is determined endogenously through a supply of hours function. "Equilibrium" is assumed in the market for "hours" but not in that for "workers".

In contrast the product market is allowed to clear, though this is somewhat contrived by arbitrary quantity adjustments. Rather than allow the external account or inventory investment to take the strain of excess supplies or demands, the modellers allocated the supply-demand gap in the product market to three demand components: government consumption and investment expenditures and private housing expenditure. This arbitrary allocation does devalue somewhat the demand and "expenditure" breakdown of GNP, but doubtless other adjustments would either have been computationally hazardous or equally arbitrary. The Japanese model then characterizes the product market as being in equilibrium and the labour market as being in excess supply. Equilibrium in the product market is not achieved by price adjustments, but by accommodative quantity adjustments on the demand side. Seven price deflators are included, each having a labour cost mark-up component adjusted for productivity change.

GNP on the income side is divided into corporate and wage income. On the expenditure side, private consumption is divided into medical and non-medical components. The inflation and unemployment rates exert separate influences on non-medical consumption as do non-transfer disposable income and transfer payments. Medical consumption expenditures are estimated in nominal terms and private fixed capital formation depends on both past accumulated savings (supply of funds) and real output growth (demand effects).

The outstanding feature of the Japanese model is its detailed modelling of social security arrangements. Here naturally the effects of an aging population will be most acutely felt. This sub-model is more complex and larger than either economic or demographic models, for it is designed to reflect the institutional detail of Japan's complicated social security and medical insurance arrangements. Its purpose is to analyse the burden placed on the economy of increasing numbers of aged dependants. Two financing arrangements for public pension schemes are included: the reserve financing principle and the pay-as-you-go scheme. The latter is assumed to replace the former when its contribution rates are reduced below those of the reserve financing schemes.

D. ECONOMIC MODELLING APPROACHES

Perhaps the most marked differences between the three country models lie in their economic structures. In this section these differences are highlighted and analysed.

(a) *Macro/sectoral models*

The Indonesian modellers have adopted – in line with the popular planning model approach – a sector specific approach. The aggregate level of output is determined simply by summing the sectors' contributions to value added. Expenditure side components are required simply to compute the overseas funding that is required to support a given investment programme.

Both Japanese and Korean models are more strictly macro-models, though in the latter considerable regional detail is present in the demographic sub-model. The Japanese model in particular provides no industry sectoral detail at all whilst the Korean model provides the industrial composition of GNP as a set of side equations. The level of GDP is determined by aggregate demand variables in the Korean case and by aggregate supply variables in Japan. Sectoral detail is 'cosmetic' and plays no real part in "driving" the model.

There are clear advantages to both sectoral and aggregative approaches. Purists might argue that economic-demographic modelling involves such lengthy time horizons as to make sectoral detail either meaningless or impossible to include. As structural adjustments are made over these long periods, the complex interrelationships that determine sectoral detail are extremely difficult to model formally and some would argue that they are best omitted.

On the other hand, as the Indonesian case illustrates, sectoral detail is often central in planning exercises. Modellers who ignore it, even in perspective exercises, may lose the interest of policy-makers and planners themselves. Moreover to some extent modelling the interactions between economic and demographic variables requires some disaggregation, as the points of contact between them often arise in specific sectors (e.g. education and health, social security arrangements etc.). Furthermore some degree of sectoral disaggregation is always possible (say primary, secondary and tertiary sector classification) and a certain amount is already understood concerning the long-run behaviour of these in the development process (see, for example, Chenery and Syrquin).

(b) *Equilibrium and disequilibrium approaches*

An important modelling strategy concerns the choice of equilibrium and disequilibrium approaches in characterising the behaviour of product and labour markets. It is a controversial area in modern business cycle analysis: equilibrium modes of analysis (associated with, *inter alia* Lucas (1975), Barro (1976)) have recently challenged the orthodox Keynesian interpretation of business cycles (restated in recent times by Barro and Grossman (1971), Malinvaud (1977)). Whilst the analysis of cycles may require explicit recognition of price and other rigidities and their associated disequilibrium effects, the analysis of the long-run behaviour of economic systems may more safely proceed on equilibrium lines.

It is of interest then to note that the models under view have all incorporated (in some cases implicitly disequilibrium features. These are set out in tabular form in Table XVII.3. In the Indonesian model alternative assumptions were adopted in each productive sector in turn, at the discretion of the modellers. The functional forms in each case were often determined by data availability and were necessarily *ad hoc* in nature. By contrast, the labour market clears in the Indonesian case, and labour productivity in agriculture adjusts to ensure full employment.

In the Republic of Korea aggregate demand determines output, with supply accommodating demand changes. With excess supply of labour, the model is Keynesian in character, with firms able to produce at the level required by aggregate demand.The model presents a somewhat *ad hoc* treatment of the mechanisms at work in situations of excess labour demand. For here firms are rationed in labour markes and may not in practice be able to produce what is demanded. The model without full explanation assumes that labour productivity adjusts to satisfy equilibrium in the product market.

In the Japanese model aggregate supply considerations determine output and aggregate demand adjusts to ensure product market equilibrium (through public expenditure and housing investment). On reflection this assumption may not be all that unreasonable: it is tantamount to assuming that government expenditure is used to ensure that there is adequate demand to meet current supply. However full employment is not achieved because of sluggish labour market adjustments, and government expenditure is not deployed to ensure full employment (as it clearly could do in the Japanese model). Given output and the product wage, firms demand profit-maximizing quantities of labour; the

Table XVII.3. Modelling approaches in product and labour markets

	Labour Market	Product Market
Indonesia	Equilibrium	Alternative Disequilibrium Regimes
The Republic of Korea	Disequilibrium	Equilibrium
Japan	Excess Supply	Equilibrium

output produced is met by an equivalent level of aggregate demand, but the labour market is generally characterized by excess supply.

None of the models made separate behavioural assumptions about supply and demand with price adjustments ensuring equilibrium in each case (as for example in the computable general equilibrium model of the Republic of Korea by Adelman and Robinson (1978)). The general approach has been to model "quantities" traded having either a supply- or demand-orientation, with implicit or explicit accommodation on "the other side" of the market. This certainly has considerable computational advantage (as experience with the computable general equilibrium models has shown). The approach adopted does raise the important question of which "side of the market" should be modelled to provide an explanation for the relevant quantity movements, in cases where only one blade of the "Marshallian scissors" is thought to be important quantitatively. The advantage of the Indonesian approach is that it allows the modeller some flexibility in choosing between alternative approaches in each sector. The Korean model had, I suspect, a shorter-run perspective, and a Keynesian approach was thought suitable, with supply accommodating to demand factors, but with wage rigidity. In contrast the Japanese model – with its concern over longer-term issues – explained output in terms of aggregate supply factors and demand played the accommodating role. Naturally the details provided by the models on the "accommodating side" (capital formation in Indonesia, labour productivity and industrial breakdown of activity in the Republic of Korea and aggregate demand components in Japan) do not directly affect the behaviour of the model at all: they are best thought of as "side equations".

E. RECURSIVE OR SIMULTANEOUS MODELS

The numerical problems associated with solving sets of simultaneous equations are a real incentive to maintain the recursive nature of the models. No doubt these considerations were central to the Korean and

Indonesian approaches. The Korean economic model was simultaneous in nature, but an analytical reduced-form solution was possible. The Japanese model alone required a numerical solution for its simultaneous equations, some of which were highly non-linear. Alternative solution algorithms were tried. Clearly where computing facilities and resources are a major constraint on model design, recursive models are attractive and modellers in such cases must take care in estimating to preserve that character. However the development of highly efficient solution algorithms may lead to less caution in this area in the future.

F. ESTIMATION PROCEDURES

The estimation of behavioural equations was by ordinary least squares in all three studies. A number of potentially serious econometric problems were contronted in each case, but solutions were not available or possible. These included the following:

(a) The use of ordinary least squares procedures leads to bias in estimating simultaneous equations. Whilst alternative estimation techniques are available, they were not used in any study. This may have been through the lack of suitable computer software.

(b) In the Indonesian case the model was estimated in simultaneous form (i.e. with current-dated endogenous variables on the right hand side of equations) but computed in recursive form (by lagging the right hand side endogenous variable by one period). Thus current income and total fertility are regressors in explaining education variables but their lagged form appears in the computational sequence. This sometimes arises in the use of cross-section data: the dynamic adopted is abritary in the absence of time-series evidence.

(c) Problems of serial correlation in the residuals are extensive but largely uncorrected. Reported Durbin-Watson statistics are rarely in the satisfactory region and more commonly indicate decisively that first-order serial correlation is present. This is not merely a statistical nuisance in that the estimates are not efficient. It suggests that the equations are misspecified (some key variable omitted?) and may indicate the presence of the spurious regression problem (see Granger and Newbold).

In general the parameter estimates used in the models were derived from country-specific time-series or cross-section data. These may not be adequate, of course, to capture the long run relationships involved in demographic-economic modelling. For this reason the Korean modellers used data from Japan to extend the range of the data used. But in general equations that were included were estimated on the basis of country data only. There may be occasions when such an approach may be misleading: for example if the time series used is inadequate to capture an important demographic or economic relationship or if no such data exist, it may be preferable to include parameters not derived from national sources. Bachue Philippines adopted such an approach in estimating its fertility function (see Rodgers and others, 1976).

G. CONCLUSION

In this chapter we have outlined and compared the demographic and economic sub-models adopted in each of the three country studies. The approaches adopted in each case were very different especially in the economic sub-models. The differences in model design did not reflect the stage of development attained in the country so much as the questions being asked of the model. The Indonesian and Korean models were more concerned with problems associated with a more conventional planning period: the Japanese model was more concerned with providing a longer-term perspective. Their economic structures reflected these differences.

Chapter XVIII

ECONOMIC-DEMOGRAPHIC INTERACTION IN THE THREE MODELS

In this chapter we compare the approaches adopted in the three country studies to modelling economic-demographic interaction. After reviewing the degree and nature of interaction adopted in each case separately we then consider the extent to which the models reflect the important features of the emerging consensus on demographic-economic interaction.

A. ECONOMIC-DEMOGRAPHIC INTERACTION

Economic-demographic interaction naturally involves a two-way relation: demographic effects on economic variables on the one hand and economic influences on demographic variables on the other. The following sections analyse both of these in each of the three countries.

(a) *Indonesia*

As we have seen, output in the Indonesian model is determined by a number of *ad hoc* sectoral equations, some reflecting supply and others demand considerations. Demographic influences are not to be found in any of these equations. Moreover value added in government services is not linked formally to the educational variables. In contrast the effects of economic variables on population are important in the Indonesian model. The levels of income (or consumption) and education affect both fertility and mortality. The interaction is strengthened by the fact that the education variables which influence fertility and mortality are themselves affected by income and fertility (the model's interactions being recursive in nature). Moreover fertility is affected by the structure of the economy, as the proportion of the population in agriculture is an important determinant of fertility behaviour.

In the Indonesian case, therefore, total output and income are largely independent of demographic influences: welfare indication (like GDP *per capita)* will be affected by demographic changes definitionally. The 'core' of the Indonesian model economy consists of the assumptions made about sectoral growth: and these affect educational and demographic developments profoundly. The interaction between the sub-models in the Indonesian case is one-sided.

(b) *The Republic of Korea*

As in the Indonesian model, the influences of demographic variables elsewhere in the models is somewhat limited in the Korean model. The modellers admit that the "model has a very limited interaction between the demographic sector and the economic sector. The demographic sector in the model influences the economic sector only through the consumption function." Output is demand-determined and the only element of aggregate demand influenced by population is private consumption. This arises because the variables are expressed in *per capita* adult equivalent terms. For this reason fairly dramatic demographic changes are necessary to have perceptible effects on output. As in the Indonesian case, demographic change has its only real influence on the denominator of GDP *per capita.*

In the Korean model somewhat more attention is given to the demographic effects of economic development. Even this is limited – so much so that the modellers explain that their simulation experiments only analyse the "effect of various *population policies* on the size and composition of population and labour" (italics added).

The level of income influences both male and female life expectancy at birth. Income also affects the mean age at child birth and through this the age specific fertility rates: however the total fertility rate is independent of income. The modellers explain: "Until the crucial linkage is reasonable well established between the economic sector and the fertility variable, policy analysis .... is bound to be very limited."

Whilst income has an influence on one Korean education variable (enrolment) it is the other (i.e. proportion educated to high school level and above) that influences the demographic model through its effect on the mean age at child birth.

Of more interest in the Korean model is the effect of economic development on migration. The difficulties encountered in injecting a regional dimension to the economic model have inevitably led to less detailed modelling in this area. Urbanization and migration are affected only by economy-wide labour productivity, with very little theoretical support offered for this relation. Of some interest is that economy-wide labour productivity varies with the nature of labour market disequilibrium, though this aspect is not developed in the similation experiments.

As with the Indonesian case there is no attempt to link demographic and education variables to government consumption expenditures. A possible justification for this approach is that governments make adjustments elsewhere to accommodate changes in educational and demographic expenditures leaving total expenditure unchanged.

(c) *Japan*

Total fertility in the Japanese model depends on the age of first marriage, the labour force participation rate for women aged 25-34 and income *per capita;* the age of first marriage is itself a function of educational enrolment for women aged 15-24. Life expectancy at birth for males and females depends on *per capita* medical expenditures, with a maximum of 77.4 years and 81.7 years respectively for males and females. Household size is a non-linear function of output per head.

Participation rates for males and females aged 15-24 depend on educational enrolment; for older males (over 60) pension benefits influence participation whilst for older females (55 and over) employment status is an important determinant.

The effects of demographic changes on economic development in the Japanese case are channelled through the adoption of the aggregate production function. Whilst the adopted form of this function makes allowance for varying vintages of capital, no attempt was made to model changing productivity when the labour force itself is aging. This is understandable in the light of limited historical experiences (world-wide let alone in the Japanese case). Changes in fertility or mortality will influence output when these changes are reflected in the size of the labour force.

Savings and through it capital accumulation are not directly influenced by demographic changes, though the modellers did try to include an age-composition variable (proportion of the male population over 25) in the consumption function (without success). In the light of the life cycle hypothesis this omission is disappointing as no modelling effort to date has successfully combined the neoclassical production function approach to demographic-economic modelling with a life-cycle model of savings. It could be that the demographic composition variable included in the consumption function was the wrong one. If the objective was to capture life-cycle effects through the inclusion of a single variable, the proportion retired may have been more relevant. The issue does raise an interesting problem for modellers: the life-cycle effects were excluded because econometric investigations failed to indicate statistical significance. This is not surprising if the particular variable included has shown little variance historically. A true relationship is masked by lack of variation in the independent variable. Those variables which in the past have shown little variance, may, in the future assert an important influence in the economy. In the field of demographic-economic modelling this problem is likely to arise in several forms. Modellers may therefore prefer to include a variable even when its significance in time-series studies to date is doubtful. This option would be taken only when economic or demographic theory indicates strongly that the effect may be important. In any event the Japanese modellers omitted demographic-composition effects from the savings function, finding no time-series support for its role.

The composition of output (as distinct from its level) is affected by demographic change through the fact that the consumption function is specified in *per capita* adult equivalent terms and through the fact that housing investment depends on the number of households.

In the Japanese case then, demographic changes have direct if delayed economic effects through the use of the Cobb-Douglas production function. Demographic variables are also influenced by economic development: fertility is made to decline as income *per capita* rises and mortality falls with increasing medical expenditures. Education is exogenous in the Japanese model. It plays, nevertheless, a key role in determining fertility (both directly and through the age of first marriage) and participation rates. Female participation in market activities is seen as an important influence on fertility.

B. ASSESSMENT

The nature of the economic models in each case results in inevitable differences in the ways in which demographic influences are felt. Only in the Japanese case, however, can one expect quantitatively important economic effects of demographic change. This arises from the economic models selected to imitate the development process rather than through any real underlying features of the economies.

In no model did demographic influences on savings play a part in economic-demographic interaction. This is a surprising gap. Indeed in the earliest models of economic-demographic interaction (albeit somewhat "one-sided" models) the demographic effects on savings were thought to be fairly crucial or they gave

rise to a fairly extensive literature on the subject (see N.H. Leff, 1969, for example). Had the modellers attempted more in this area demographic influences on economic development may have been quantitatively more important. In the Indonesian model they would certainly have influenced funding arrangements; in the Keynesian Korean model aggregate demand would be affected and in the Japanese case capital accumulation would depend more on demographic changes. The Coale and Hoover (1958) model illustrated one possible effect: output they assumed was a function of capital alone whilst savings were adversely affected by high fertility. In consequence higher fertility reduced output. The validity of the second stage in this argument (viz. the harmful effects of fertility on savings) has been the subject of debate, but the linkage illustrates one key mechanism neglected in all three models.

The Japanese model has made more allowance for demographic influences than either of the other two cases. This arises from the fact that in the Japanese case longer-run interaction is considered and supply-side effects dominate. In both the Republic of Korea and Indonesia labour supplies are not relevant for output determination, and demographic effects are at best negligible.

The models make more headway in allowing for the influence of economic change on demographic variables, with the Korean model including the weakest linkages here. Changes in income per head had important demographic effects in each study: on fertility and mortality in Indonesia; on mortality in the Republic of Korea and on fertility in Japan. Output composition effects also has fertility effects.

Geoffrey McNicoll (1978) has argued that there has been "a narrowing of views on relationship between population and development". In particular a consensus view has emerged amongst those who advocate "supply-side" policies for fertility reduction (family planning programmes etc.) and those who emphasise demand-effects ("development is the most effective contraceptive"). Whilst McNicoll is critical of this emerging consensus, it is convenient, for our purposes here, to quote his own statement on what constitutes the consensus view. He argues the view has six elements:

"(a) An industrialised society, once within reach, brings with it sufficient conditions for population growth and fertility to drop to low levels.

(b) The mechanisms by which fertility falls, although still not fully explicated, essentially entail responses by parents to one or more of the following perceived changes: increasing costs (absolute or relative, and including opportunity costs) of having and raising children, lessened advantages derivable from children, easier means of fertility regulation, and improved child survivorship prospects.

(c) Certain components or concomitants of development, such as urbanization, freer access to education, and greater labour force participation of women outside the household, have significant fertility-depressed impacts (sometimes only above a threshold level), presumably acting through the mechanisms just mentioned.

(d) Programmes that make family planning knowledge and services widely available can contribute significantly to lowering high fertility and are also beneficial in themselves by extending freedom of choice in fertility matters.

(e) By stressing the relationships noted in (c), an overall strategy for economic and social development can be oriented so as to ease sooner than would otherwise happen the high-fertility burden on the development effort.

(f) Happily, a more equal income distribution and the provision of 'basic needs' of the poor, not only no longer seem incompatible with rapid economic growth but also have a favourable fertility pay-off."

How do the three models in this report compare with these characterizations? All three models allow for effect similar to that given in (a), though in the Republic of Korea this is somewhat crudely represented in a time-trend (though income per head in the Republic of Korea is likely to follow a time-trend itself).

The models understandably make no attempt to incorporate the mechanisms by which fertility falls (b). However they do cover some of the effects considered in (c): urbanization (proxied by the proportion of the population in agriculture) influences fertility in Indonesia (at an early stage of demographic transition); education influences fertility in Indonesia and Japan, whilst female participation outside the household has fertility effects in the Japanese model. No model explicitly allows for family planning programmes as such (d) but *ad hoc* adjustments permitted simulation of alternative programmes in some instances. Whilst in

principle the models might be illuminating concerning (d), in practice they were only partially successful. Whilst key educational variables were modelled to have fertility effects in Japan and Indonesia, they were generally exogenous. Simulation experiments (considered in detail in the next chapter) were not in general designed to answer the interesting questions raised in (e). The models were not designed to handle questions of income distribution raised in (f), but computer models are ideal for handling the complex issues involved in this area.

In general, then, many of the features of emerging consensus are found in the models, though this is more true of Japan and Indonesia than it is of the Republic of Korea. They do not shed any light on the complex issues of causation in this area: they model aggregative relationships (between fertility and education for example) without attempting to disentangle the direction of causation. In this, to a large extent, they simply reflect the current state of the art.

Chapter XIX

SIMULATION COMPARISONS

The three models under review display important differences both in economic structure and in the nature and degree of economic-demographic interaction. To some extent the differences in economic structure reflect the time period of interest to the modellers. The Keynesian Korean economic model in particular has relevance over much shorter periods of time than the neo-classical Japanese model.

To some limited extent it could also be argued that differences in structure have arisen because of the varying stages of economic development reached in the three cases. Structural change is likely to be most pronounced in Indonesia so that a sectoral rather than an aggregate model was preferred. In Japan and (to a lesser degree) in the Republic of Korea prospective structural changes are likely to be less pronounced, and in these cases macro-relationships only were modelled.

In the simulation experiments, the policy scenarios covered and their implications were naturally closely linked to the type of economic model built. We shall see that limited policy analysis was conducted in the Korean case because the degree of interaction was minimal. The simulation experiments focussed more on demographic-labour market interaction. In the Indonesian and (especially) in the Japanese cases, more ambitious simulation experiments were possible.

To some extent the main interest in this study lies in the simulation results. The three models were developed independently by the three country teams with very different problems in mind. The comparison of their simulation experiments, especially in the area of economic-demographic interaction, is the principle purpose of this report. We shall review the three sets of experiments on a country-by-country basis and then form an assessment of the results.

A. COUNTRY SIMULATIONS

(a) *Indonesia*

Three simulation runs were reported in the Indonesian case. The "reference run" which reflects the historical trends in Indonesia, is called "high growth-high fertility" (HGHF). A second simulation adjusts downwards the growth performance of key sectors (manufacturing, forestry and mining and quarrying) and is referred to as the "low growth-high fertility" case (LGHF). As with HGHF this simulation maintains the model's original assumptions about fertility behaviour. A third simulation run maintains the growth assumptions of LGHF but allows fertility to fall by 50 per cent over the period 1970-2000 (in HGHF fertility fell by 25 per cent up to 2010). The growth rates of output (Y), population (P) and output per head ($y = \frac{Y}{P}$) in the reference run (HGHF) are given in Table XIX.1.

Table XIX.1. Annual growth rates of Y, P and y: Indonesia

	1979	1990	2000
Y	5.20	11.38	12.32
P	2.01	2.48	2.22
y	3.12	8.68	9.88

Population growth peaks in 1990 and falls off thereafter. Output and output per head grow at increasing rates throughout the simulation period, with output per head accelerating after population growth begins to slow down.

The Indonesian model was designed to allow for structural changes and these were evident in HGHF: the share of agriculture in GDP fell from one third in 1979 to 14.05 per cent in 1995, whilst the share of value added in manufacturing rose from 13 per cent in 1979 to 24 per cent in 2010.

The dependence of the Indonesian economy on foreign funding declined over the simulation period: 20 per cent of gross domestic capital formation was funded from overseas in 1979 whilst only 3.4 per cent was similarly accounted for in 2005.

Over the period 1970-1990 agriculture continued to absorb labour from other sectors where there was a general deficiency of labour demand. Employment in agriculture is expected to rise from 37.7 million to 40.1 million over this period. In subsequent years the non-agricultural sector is seen to absorb a growing fraction of the labour force, so that agricultural employment is expected to fall to 26.9 million by the year 2000.

As a result of real income growth and the expected expansion in educational provisions, mortality and

fertility decline by 50 per cent and 25 per cent respectively up to the year 2010.

Comparisons of the three simulations can give some indication of the degree of economic-demographic interaction in Indonesia. Comparing HGHF and LGHF for example gives some indication of the effects of economic growth upon demographic variables. Alternatively a comparison of LGHF with LGLF provides some indication of the effects of fertility change on economic performance in general and measures of economic welfare in particular.

Under HGHF, population is expected to reach 288.82 million in the year 2010, and 300.157 million under LGHF. The higher growth of output has lead to a significantly lower population by the end of the simulation run, though this only became pronounced after 1990. GDP per head was 1,161.1 (thousand Rps) under HGHF in 2010 and 729.4 (thousand Rps) under LGHF. In LGHF the fertility effect of lower growth (which increases the population size) and the direct output effect operate in the same direction so that output per head actually falls in the low growth simulation.

Comparisons of LGHF and LGLF are equally revealing. GDP in 2010 is expected to be 218,925.9 billion Rps under LGHF and 215,316.3 under LGLF. Lower fertility is expected to lead to a lower GDP level at the end of the simulation run in *per capita* terms, GDP is 729.4 (thousand Rps) under LGHF and 877.8 (thousand Rps) under LGLF. Thus whilst total output is lower, the effects of decreased fertility on population leads to an increase in economic welfare as indicated by GDP *per capita.* Policies aimed at reducing fertility are thus seen to have beneficial welfare effects (as far as these are accurately measured by GDP *per capita*) in the Indonesian economy.

(b) *The Republic of Korea*

We have already noted that the Korean model is less amenable to analysis of economic-demographic interaction. The authors admit that 'policy analysis of the model is limited to seeing the effect of various *population policies* on the size and composition of *population and the labour force'* (italics added).

A basic prospect for the Republic of Korea is derived, and simulation experiments of alternative policies compared with the basic prospect. In the basic prospect the total fertility rate is expected to decline from 2.7 in 1981 to 2.3 and 2.1 respectively in 1990 and 2000. Population growth declines to 1.0 per cent per annum in 2000 and 0.74 per cent per annum in 2010. The proportion of the population in urban areas rises to 82 per cent in the year 2010. The dependency burden falls from 59.4 per cent in 1981 to 50.7 in 1990 and 43.5 in 2010. Unemployment is higher than its frictional level up to 1994 (hovering at 5 per cent) but falls from this date to its minimum level of 3 per cent. This suggests excess supply of labour until 1994 and excess demand (or equilibrium) thereafter.

Three types of alternative simulations are considered: assumptions are changed on fertility, emigration and population redistribution. These are now considered in turn.

Higher fertility assumptions (compared with the Basic Prospect) are made concerning the periods 1982-1986 and 1982-1991. As the results were similar in both cases only the first will be considered here. The fertility assumptions had predictable and pronounced demographic effects, but these are of limited interest in economic-demographic modelling. The effects on the economic model were predictably negligible (due to the nature of the economic system) and the simulation reports do not give any quantitative information on the economic effects. However labour market effects were reported. The higher fertility assumptions depressed the labour force participation of women (of the relevant age) and reduced the total supply of labour. As demand for labour was unaffected by the alternative fertility assumption, unemployment was lower than that of the Basic Prospect until 1990.

The Korean modellers also analysed the effects on population and the labour market of preventing emigration after 1982 in one case and after 1992 in another. As the composition of emigrants was identical to that of non-emigrants, the effects on population and the labour market were fairly predictable. In particular the resulting higher labour force caused the unemployment rate to rise.

The final set of simulation experiments concerned population re-distribution policies. Migration rates over the period 1965-1970 were taken as an indication of the extent of migration if there were no redistribution policies. The model under the Basic Prospect applied migration rates that followed from the relationship between the urbanization rate and labour productivity. Again no redistribution assumptions were applied post-1982 and post-1992. Urbanization and migration rates were higher than the Basic Prospect and in consequence total fertility and participation rates were lower. The size of the labour force and the unemployment rate were consequently lower.

The size of population was influenced more by

policies that changed fertility and by emigration policies than it was by policies aimed at population redistribution (as urban-rural differences in fertility were already significantly narrowed). "For the controlling of the size of population", write the Korean modellers, "fertility control is more effective than emigration." The economic effects of the alternative assumptions were not considered.

(c) *Japan*

The Japanese model allows for the most complete and most varied economic-demographic interactions and the simulation experiments to a large degree reflect this. Five alternatives are compared with a "standard case". These are alternative fertility, alternative mortality, low welfare, fast capital replacement and alternative taxation cases.

The standard case itself provides an intriguing prospect for the Japanese economy. Declines in fertility and mortality give rise to a rapidly aging population. The proportion of the population aged 65 and over increases from 9.1 per cent in 1980 to 23.88 per cent in 2021. This growth is more marked than other forecasts: the Nikon University projection was for a ratio of 21.50 per cent in 2020 and the Ministry of Health and Welfare forecast was 21.82 per cent in the same year. The authors conclude that "the computed result of this study shows that Japan's aging level . . . will be very likely the highest ever in the history of mankind."

As expected fertility effects dominate the lower end of the "population tree", the dependency ratio declines over the early years of the simulation, reaching its lowest value of just over 40 per cent in 1990. Thereafter it climbs, as the proportion of old people starts to dominate.

In the reference run, the growth rates of real GNP and GNP *per capita* fall off over time, but GNP *per capita* grows at a rate in excess of GNP after 2007. Unemployment fluctuates somewhat, from 1.153 million in 2011 to 1.386 million in 1995. This indicates excess labour supplies throughout the simulation period.

The effects of aging are naturally felt most acutely in the social security sub-model. The financing schemes for the Employees Pension Scheme shifts from reserve financing to pay-as-you-go (PAYG) financing in 2005. A similar switch occurs in the National Pension Scheme a year earlier. On the medical side, total medical costs are expected to rise at a remarkable rate over the simulation period, due in part to a rapid increase in individual treatment costs. These rising total costs give rise to substantial increases in medical insurance contributions and government subsidies. The contribution rate rises over the simulation period from 8.9 per cent to 28.6 per cent.

At the start of the simulation period, medical benefits paid out exceeded pension benefits in the social security sub-model. In the early part of the next century, according to the standard case, pension benefit payments will dominate the others. The authors have particularly sought to draw attention to the increased financial burden that accompanies a rapidly aging population.

The first alternative simulation experiment adjusted the assumptions on fertility: a high fertility assumption (TFR fluctuating around 1.8) was compared with a low fertility case (TFR falling to 1.505 in the terminal year of the simulation period). These experiments yielded fairly predictable demographic effects, *viz.* the high fertility case gave rise to lower indicators of aging, and led to a larger population.

The alternative assumptions on fertility led to no pronounced effects on nominal GNP over the first 20 years of simulation, but differences were noted for real GNP. In particular the low fertility assumption led to a slightly larger level of real GNP compared with the high fertility case over the period 1995 to 2004. From 2005 onwards higher fertility was associated with higher real output. These results imply that low fertility is associated with a faster inflation rate. More importantly perhaps, real GNP *per capita* was always higher in the low fertility case. The direct effect of fertility on population size dominated its effect on GNP *per capita* through its influence on the numerator.

The second alternative simulation concerned changes in the assumptions on mortality. The alternative simulation followed the survival pattern assumed by the Ministry of Health and Welfare, which generally lowered the life expectancy at birth (*cf.* the standard case). The alternative assumption led to only marginal effect upon economic and social security variables, though GNP *per capita* was higher under the alternative mortality assumption, the difference widening in relative terms over the simulation period. (Real GNP is expected to be slightly higher in the standard case due to a larger labour force.) Naturally increased mortality lowers the proportion aged.

In the third simulation, an alternative assumption is made concerning pension benefit payments – "the low welfare case." The smaller persion handouts naturally reduce the financial burden of the social security system. Real GNP is only 0.67 per cent larger in the year 2000 when compared with the standard case, but by

2025 this gap is expected to widen to 4.47 per cent. The reduced burden is more immediately felt in the ratio of social security benefits to national income (which is 44.55 per cent in 2025 compared with 48.70 per cent in the same year under the standard case).

In the fourth simulation experiment, a faster capital-replacement rate is assumed, one that follows the replacement characteristic of the United States economy over the period 1966-1977. This has the effect of slowing the growth of the capital stock. Differences in real GNP are negligible up to the year 2000, becoming more pronounced thereafter (leading naturally to lower levels of GNP). The annual growth rate of GNP falls below 1 per cent in the year 2017. In the final year of simulation, GNP *per capita* was 13.7 per cent smaller than that in the standard case.

The final experiment compared alternative taxation policies designed to fund negative government savings which occur primarily because of increasing social security payments after the year 2004. There are negligible demographic effects of these policy options, as would be expected. An increase in direct taxes tends to lower GNP and its growth rate compared with an increased indirect tax burden.

B. ASSESSMENT

Due to the weak interactions allowed for, the Korean simulation experiments are limited in scope. Alternative population policies are evaluated in terms of their demographic and labour-market effects. Output and the demand for labour are largely independent of such policies. The results of these simulations while of value to those interested in Korean demographic prospects are of less value in analysing the interaction of demographic and economic developments.

The Indonesian and Japanese simulations provide more scope for economic-demographic interaction, with the latter offering a wider range of alternative policy scenarios. Demographic effects of alternative economic growth assumptions were seen to be quantitatively important in Indonesia, with lower population growth limited with improved economic progress. The demographic effects of faster growth thus reinforced direct output effects to unambiguously improve economic welfare as indexed in GNP *per capita.*

Evaluating the effects of slower economic growth on demographic variables in Japan is more problematical. Discussion of the one simulation that would be illuminating in this respect – the higher capital replacement alternative – is limited, and little information is given about demographic effects. However the authors do state that GNP *per capita* is 15.8 per cent smaller than that for the standard case in 2025. Since GNP estimates are provided for the alternative case, one can calculate for the terminal year the effect of the higher capital replacement alternative on population size. The relevant statistics are given in Table XIX.2.

Table XIX.2. Estimates of GNP *per capita* and population : Japan 2025

	Population (millions)	GNP (trillions yen)	GNP *per capita* (millions yen)
Standard Case	124.904	755.19	6.046
High Capital Replacement Case	128.096*	652.1	5.0907*

* Estimated from available statistics.

The slower growth of output – occasioned through a slower growth rate of capital stock – has resulted in a larger population. As in the Indonesian case, the demographic effects of slower economic progress affect output *per capita* in a fashion that reinforces the direct output effects, so that output per head unambiguously declines under slower total output growth.

The economic effects of demographic changes are also clear in the Indonesian and Japanese simulation experiments. Despite their very different economic structures both models predict that output per head is improved with declining fertility. The result can be seen in Table XIX.3.

Table XIX.3. Output per head under alternative fertility assumptions: Indonesia and Japan

	Output per head*		
	(1) High Fertility	(2) Low Fertility	Ratio of (2) to (1)
Indonesia (2010)	729.4	877.8	1.203
Japan (2010)	4.554	4.694	1.031

* Output in GDP in Indonesia and GNP in Japan. The figures given are in the country's own currency.

Whilst no attempt has been made to ensure comparable fertility changes in the two countries, the table does indicate that welfare effects of fertility change are pronounced in both models, notwithstanding the very different economic structures involved. In both cases output is higher under high fertility than it is under low fertility (1.676 per cent higher in 2010 in Indonesia and 0.183 per cent higher in the same year in Japan), but the direct effects on the denominator caused output per head to rise in both cases under low fertility assumptions. The positive output effects are not sufficient to outweigh the harmful demographic effects of higher population size.

It is interesting to note that these similarities exist between models of countries which are expected to experience very different growth prospects: in Indonesia output growth prospects are good, with accelerating growth over the simulation period whilst in Japan output growth is expected to slow considerably.

C. CONCLUSIONS

The simulation experiments will naturally be of considerable interest to demographers and economists in each of the three countries. They contain country-specific effects which are of value in their own right. For our purposes here, the simulations are interesting in the ways they demonstrate the quantitative importance of demographic-economic interaction, and these are most evident in the Indonesian and Japanese cases.

In these two countries the interaction between economic and demographic development is pronounced. Economic progress leads to lower population pressures; lower fertility has limited output effects so that the economic welfare of the surviving population is improved. The models thus confirm many of the elements of the emerging consensus on the interaction of economic and demographic variables.

Chapter XX

CONCLUDING REMARKS

The studies which comprised the bulk of this report represent three independent views of economic demographic interaction. Whilst demographic modelling in the three cases moved along fairly similar lines, the economic sub models in each case were quite different.

Despite the considerable differences in their economic structures, the models of Indonesia and Japan – countries at very different stages of economic development and demographic transition – yielded the same "anti-natalist" results. Low fertility has beneficial effects on economic development; economic development has important and desirable demographic effects.

At the outset of the report the need was stressed for continuous improvement in model design, in part to reflect the rapid increase in empirical studies of the relevant relationships. At the close of the Korean section, the modellers set forth an agenda for further work in the modelling area. In the same spirit here, we now consider the principle areas of weakness in the current studies, with a view to future improvement on this promising start.

As the Korean modellers suggested, much has still to be learned about fertility behaviour. The aggregate linear (or log-linear) specifications inevitably mask much rich detail. What precise mechanisms link economic progress with fertility decline? Is the association linear, or are there kinds and threshold levels of income where fertility effects are reversed? Does progress affect fertility through its influence on income distribution? Insofar as the answers to these questions are being slowly uncovered in the large volume of contemporary empirical work, they must be reflected in the design and structure of computable models. This may entail modelling with richer detail in areas of income distribution and education.

The second area of concern lies in the nature of economic growth itself. The most amenable theory for linking demographic and economic development is neo-classical, with its emphasis on aggregate supply. Yet according to Kuznets (1966) only a very small fraction of output variance is explained historically by conventional inputs (less than 10 per cent). He would be the first to agree that too much weight should not be put on the exact proportion; but even if the "true figure" is nearer 50 per cent (see Leibenstein, 1971) the "residual factor" is alarmingly high. These considerations raise important questions concerning the use of the neo-classical production function (exemplified by the Japanese model in this report). This is not to say that the neo-classical approach is unhelpful – far from it. Amongst the list of candidates to explain the "residual factor" Kuznets himself included "the improved quality of resources". Modelling output successfully in the neo-classical framework may be possible if due allowance is given to quality of inputs, especially in making explicit provision for human capital considerations. This conveniently links the economic, educational and manpower sub-models.

This is not to say that making allowance for differences in input quality will be enough: Kuznets also lists "the effects of changing arrangements" amongst the candidates to explain the residual. It is difficult to envisage at this stage a quantitative proxy for this. But insofar as policy-makers have notions about non-traditional inputs, there is always the possibility of including such effects in disembodied technical progress – though this is inevitably a risky and largely *ad hoc* option.

Finally it seems to this author that more effort is generally called for in allowing for demographic influences on savings behaviour, especially in the light of the life-cycle hypothesis. One wonders, for example, whether the degree of aging expected in the Japanese economy will lead to more pronounced effects on savings and accumulation than the model predicts. The neo-classical model, with proportional savings, predicts analytically that a lower population growth will lead to increased output per head (this arises from constant returns to scale). The result may not be so straightforward if accumulation itself is affected by demographic change.

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